CORTEX

Version 2.1 Reference Manual

MotionAnalysis

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Chapter 1

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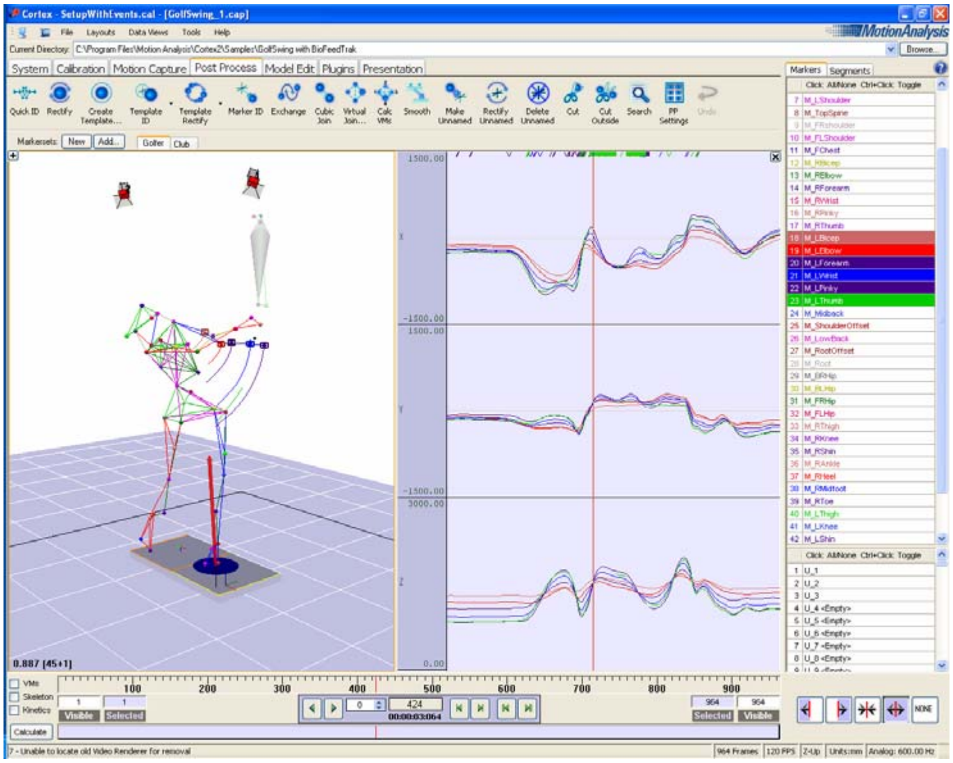
Overview

Figure 1-1. Cortex User Interface



Cortex - SetupWithEvents.cal - [GolfSwing_1.cap]

Current Directory: C:\Program Files\Motion Analysis\Cortex2\Samples\GolfSwing with BioFeedTrak

7 - Unable to locate old Video Renderer for removal

File
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Marker ID
Exchange
Cubic Join
Virtual Join...
Calc VMs
Smooth
Make Unnamed
Rectify Unnamed
Delete Unnamed
Cut
Cut Outside
Search
PP Settings
Undo
Markersets:
New
Add...
Golfer
Club
Markers
Segments
Click: All/None Ctrl+Click: Toggle
VMs
Skeleton
Kinetics
Visible
Selected
Calculate
964 Frames
120 FPS
Z-Up
Units:mm
Analog: 600.00 Hz

This instructional Reference Manual provides a complete description of the **Cortex** software and its capabilities, along with many step-by-step procedures critical to a successful motion capture project. Motion capture theory is separated from the body of this manual in the form of appendices so that the tutorial approach does not become cluttered.

Cortex is a complete package, capable of meeting the most demanding requirements of the motion capture industry. Output is generated in real-time making **Cortex** a suitable engine for a number of widely used 3D animation packages as well as custom applications created using the supplied Software Developers Kit (SDK). Being a real-time application, the results of a motion capture session can be viewed instantly while simultaneously saved in several file formats. In addition, you can graphically edit data with a complete suite of tools without resorting to other off-the-shelf software packages.

Cortex handles image data from systems comprised of up to 250 cameras. System setup and calibration is fast and simple with immediate feedback and a high degree of accuracy and precision. Motion capture sessions are managed using directory and file access tools and the motion data generated is of the highest quality. Post Processing data is accomplished graphically using intuitive controls integrated with mouse and keyboard functions for fast and easy editing. Model Edit features give you access to the properties of the current set of named markers, virtual markers, linkages, and skeletal segments.

Cortex combines three major functions into a single software package:

1. Calibration of your capture volume
2. Tracking and identifying marker locations in your calibrated 3D space
3. Post processing tools for tracking, editing, and preparing the data for other packages

The advanced calibration procedures calibrate the 3D volume with ease and accuracy.

Options for using the software include:

1. Reference video capture-synchronized with the **CortexDV** software—either on your capture computer or on one or more auxiliary computers
2. Synchronized analog channels—capable of collecting from 32 to 192 channels of analog data at any frequency between 60 and 5000 Hz
3. Genlock to your studio camera with the Motion Analysis cameras
4. Calcium/Solver—for generating constant bone-length skeletons for high quality animation
5. OrthoTrak—clinical gait evaluation module
6. SIMM—Software for Interactive Musculoskeletal Modeling
7. KinTools RT—a Real-Time kinetics and kinematics calculation engine
8. Motion Composer—used for producing, packaging, and presenting data reports

System Requirements for Cortex

Table 1-1. Required Minimum and Recommended Specifications

Required Minimum Specifications	Recommended Specifications
Dual 2.0 GHz CPU (up to 12 cameras)	Quad Core 3.2 GHz CPU
4 GByte RAM	8 GByte RAM
Windows XP Pro$^{\text{TM}}$ with .NET 2.0 or later operating system	**Windows XP Pro**$^{\text{TM}}$ with .NET 2.0+ or **Windows 7**$^{\text{TM}}$ **(64-Bit)** operating system
OpenGL video card with 128 MByte RAM capable of (1280x1024) resolution	OpenGL video card with 256 MByte RAM capable of (1280x1024) resolution
19-inch or larger monitor capable of (1280x1024) resolution	Dual 20-inch or larger monitors capable of (1280x1024) resolution
100+ GByte hard drive (IDE or SCSI)	200+ GByte hard drive (IDE or SCSI)
USB 2.0 Ports (x3)	USB 2.0 Ports (x4)
Internal CD-RW drive	Internal CD/DVD-RW
1 Gigabit Ethernet Network Interface Card (NIC), quantity dependent on the following options: • Connecting to camera network • Connecting to Internet • Streaming to SDK or plugins	Two Separate Gigabit Ethernet Network Interface Cards (NIC), quantity dependent on the following options: • Connecting to camera network • Connecting to Internet • Streaming to SDK or plugins
104 key keyboard	104 key keyboard
Three-button mouse. The program requires a middle mouse button for zooming and selecting in several of the graphical panes.	Three-button mouse. The program requires a middle mouse button for zooming and selecting in several of the graphical panes.
IEEE 1394 (standard Firewire) for Reference Video option	IEEE 1394 (standard Firewire) for Reference Video option

Hardware

Cortex will perform best on a dual processor host computer with an OpenGL graphics card. This is used for all Motion Analysis camera types.

Using Raptor, Eagle, and Hawk Digital Cameras

The Raptor, Eagle, and Hawk digital camera motion capture system includes a set of digital cameras with ring lights, LAN/power cables, and a power hub and ethernet switch.

Using Falcon Cameras

Cortex does not support collecting data with analog camera systems (Falcon, Cohu, or Pulnix cameras using the Midas computer). However, you can use **Cortex** for post processing and analysis of motion capture data captured with these analog systems.

Middle Mouse Button

For **Cortex** operations, the middle button is key for zooming and translating through the 3D and XYZ Graphs display. You will need to verify that the middle mouse button is set to the middle button function.

Software

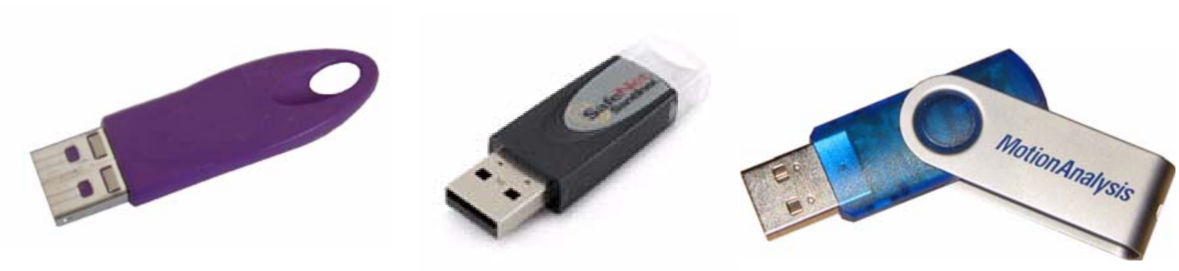
The **Cortex** program requires the host **Windows**^{TM} operating system.

Installing the Software and Licenses

To install **Cortex** for the first time, simply insert the installation CD-ROM into your computer and select the **Setup Cortex 2.1.0 No Samples.exe** or **Setup Cortex 2.1.0.exe** file. You can also download either of these files from the ftp.motionanalysis.com website.

Note: To run **Cortex,** you will need both a license file and a dongle from Motion Analysis Corporation. The license file you receive is keyed to your Motion Analysis dongle number printed on the dongle.

Figure 1-2. USB Port Dongles and Flash Drive



USB Port Dongles **Motion Analysis Flash Drive**

Installation Using the Flash Drive

For new users, **Cortex** licensing is now provided and setup using Flash Drives. For installation, please follow these steps:

Note: **Please make sure to remove all Dongles from your computer prior to running the Cortex setup file on the CD. Failure to do so may result in damage to your dongle.**

1. Install the new version of **Cortex** from the CD.
2. Install the Sentinel Drivers after the **Cortex** installation is finished.
3. Insert the Dongle into the USB port
4. Insert the Motion Analysis USB Flash drive into a USB port. Double-click on the program: Install.Mac.License and follow the instructions. Press **Y** or **Enter** and the license will be installed onto your hard drive, in the **C:\Program Files\Motion Analysis** directory.
5. On the Task bar, left-click the Green arrow icon and select **Stop USB mass Storage Device**.
6. Unplug the USB Flash Drive and store it in a safe place.

If you need any further information, please consult the **readme.txt** file located on the Motion Analysis USB Flash Drive.

If You Already Have Software Installed

If you have Motion Analysis software already installed, you will need to add a new line to your Motion Analysis license file (provided by Motion Analysis Customer Support).

1. Launch **Notepad**, **Wordpad**, or your favorite ACSII text editor.
2. Navigate to **C:\Program Files\Motion Analysis**.
3. Open the **mac_lic.dat** file.
4. Add the new line beginning with `[Cortex 2]` from your new license to the bottom of your current license as shown below.

Figure 1-3. Sample Motion Analysis License File

```
Motion Analysis License File
Customer: MAC Customer
Platform: NT
SystemID: 19c
Created: 9/15/20xx 1:42:26 PM
Sales Order#: 09-xxx
Entered By: Support
[Cortex 2]  aed50167    873b2d56
[Analog Input]       b9806c31    d1567841
[OrthoTrak]          b2df5e69    8964274a
[Animation Plugins]  b1a50160    805b5c49
[Director/Sequencer] e1a04e65    85745819
[RT2 Animation Plugins] e3f05340    a069081b
[Analog Input]       b9806c31    d1567841
[Calcium 4]          e7ed5923    c363151f
[Skeleton Builder 4] a3f44279    99780c5b
[Reference Video 3.0] eb92592f    cf636a13
[Talon Streaming 4]  ecb36136    d65b4b14
[Talon Viewer 4]     86fb0714    f43d037e
[Motion Composer]    c7f00e25    c534083f
This license has no expiration.
```

If You Install a Dongle

Computers with a new dongle installed need to load the dongle drivers so that the application will detect the dongle.

You can choose to install the dongle drivers when initially installing the **Cortex** software or you can run the drivers independently by running the program in the **Sentinel Drivers** directory under the **Cortex** folder.

Operating Systems in Different Languages

If the operating system you are using on your tracking or post processing computer is a non-English version, some characters may not be recognized and you may experience installation problems.

If you are experiencing this, you will need to go into the computer and set it to allow for English Unicode characters. In **Windows XP**, you can do this by going to **Start > Control Panel > Regional and Language Settings**. This brings up a window that has 3 tabs, and the second one is the Language Tab. Under the Text Services and Input Languages tab, you need to click on the **Details** button and add the setting for English (United States). This will add the necessary text characters to the computer.

Alternatively, you can install an English language OS on your computer.

Cortex 32-bit and 64-bit Installation Notes

The setup file provides the option to install either the 32-bit or 64-bit versions, or both. They can be installed to the same directory if desired, since the release folder name is different. Dual host computers (WinXP and WinXP x64 for example) can have both versions installed on the same hard drive. The release folder name determines the location of the executable and associated files.

On WinXP and Vista (32-bit), the default installation folder is **C:\Program Files\Motion Analysis**. Installing on WinXP x64 for Vista (64-bit), or Win 7 (64-bit), the default installation folder is **C:\Program Files (x86)\Motion Analysis**. It is recommended to use the default installation folders, but **Cortex** will run on any folder on any drive.

Limitations and Recommendations For Different Versions of Microsoft Windows

Win7 (64-bit)

This is a good all around choice for all users (Biomechanics, Animation, and Industrial). It supports all peripheral data collection devices such as Analog collection, Time Code Reader, and Firewire Digital Video cameras.

Vista Business (32-bit) standard version is a 32-bit version of Windows which is not recommended at this time. While Cortex (32-bit) runs fine with the same memory limits as WinXP, stability problems have been experienced with Vista that is unrelated to Cortex. Vista (32-bit) seems to degenerate over several weeks, has trouble booting and eventually requires reformatting the disk drive and reinstalling Vista (again).

Note: In Win7, the font size in **Control Panel > Appearance and Personalization > Display** needs to be set to **Smaller - 100%**; the default is Medium - 125%.

Pros on Using WinXP x64: 64-bit Version of WinXP

1. Allows the user to run Cortex-64 which runs 20%+ faster than WinXP (32-bit) on the same computer. Motion Analysis supplied Time Code Reader is supported and is frame accurate. Firewire Digital Video cameras collect data and run to specifications. WinXP x64 and Win7 x64 are solid and runs both Cortex (32-bit) and Cortex-64.
2. For machines that support 64-bit Windows, the user has the option to utilize more RAM. This is beneficial when you are dealing with large TRB files. Testing has exposed memory problems on WinXP (32-bit) with 130 MByte TRB files that have 4 persons recorded at 120 Hz for 4 minutes. The same files run smoothly without memory problems on the 8 GByte WinXP x64 computer.

Only Known Problem In Using WinXP x64

WinXP x64 does not support analog data collection. National Instruments drivers will not install on WinXP x64. Users can do all Post Processing and editing tasks, run Calcium, Skeleton Builder and KinTools RT, but they cannot use Cortex-64 for collecting analog data.

Where Cortex Gets Installed in Different Versions of Windows

Windows XP, Vista and 7 (32-bit Versions)

Everything is installed to the **C:\Program Files\Motion Analysis\Cortex 2** folder by default.

Note: You need administrative privileges to run software from this location since Cortex reads and writes files into sub folders from this location.

To run WITHOUT ADMINISTRATIVE privileges, copy the Cortex folder to the user's desktop. You can launch and run Cortex from there. You will want to remove the Cortex link from the desktop and establish a new one for launching Cortex.

Windows XP, Vista and 7 (64-bit Versions)

Programs get installed to **C:\Program Files\Motion Analysis(x86)\Cortex 2**.

Samples, Tutorials and UserFiles get installed to **C:\ProgramData\Motion Analysis\Cortex2**.

Note: ProgramData may not be visible after installing Windows 7 (for reasons known only to Microsoft). To make the ProgramData folder VISIBLE, you will need to search the Control Panel for "hidden". This will show the following options:

> [X] Don't Show hidden files or Folders
>
> Change to:
>
> [X] Show hidden files, folders and drives.

Note: Windows Vista users must turn OFF the feature called UAC (User Access Control) from the Windows Control Panel. If not, there will be file permission issues when running and closing **Cortex**. Use the search function in the Control Panel and search for UAC and then turn it OFF.

Firewall Settings in Windows 7

You can keep both "Public" and "Private" firewalls turned ON in Windows 7 and still collect data from your Motion Analysis cameras. From the Control Panel, you can specify which programs will be allowed to access the Ethernet on a per-program basis. You need to allow all versions of Cortex that you will use for data collection. Note that you must press the OK button for any changes to take place.

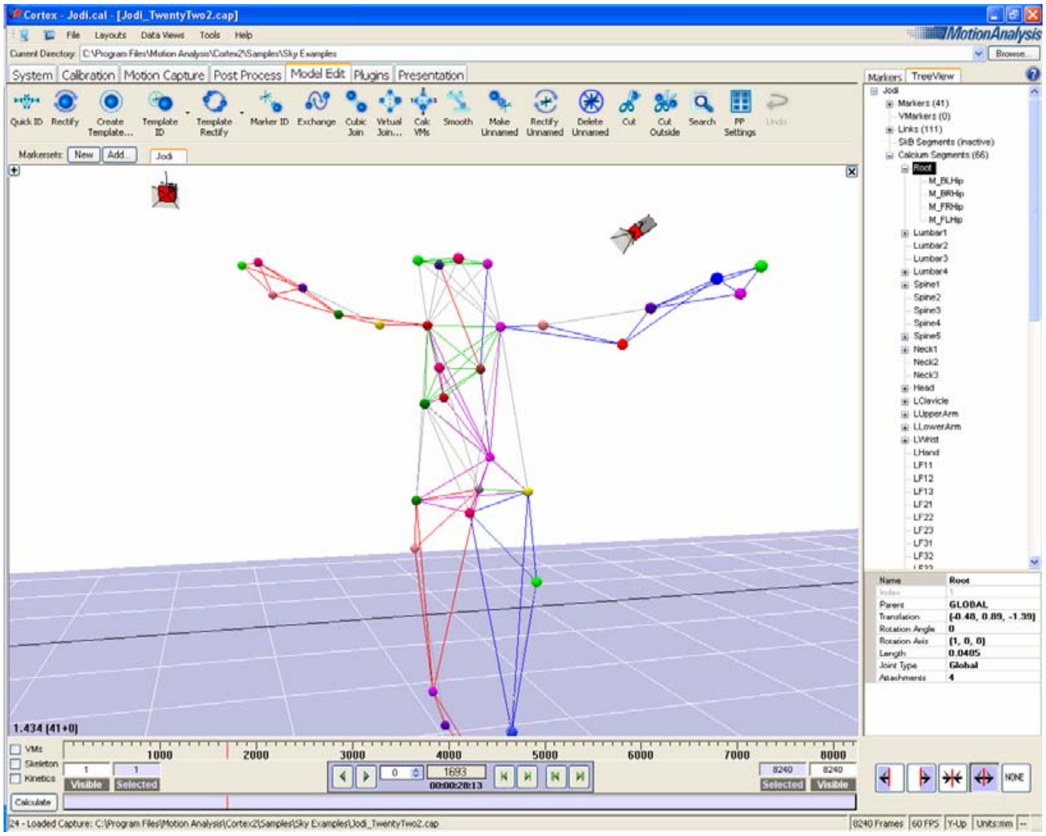
Software Packages within Cortex

The following are software products offered by Motion Analysis that are integrated within the **Cortex** user interface. These files will require a license file update.

Calcium

Calcium is the graphical user interface to the Solver engine. Solver is a powerful numerical tool for calculating skeleton motion from marker data. The Calcium interface in **Cortex** is what allows you to correlate the positions of a marker pose to the initial pose of a skeleton. The skeleton is usually created in an outside animation package, such as Maya, 3D Studio Max or Kaydara and then exported to an HTR file by a Motion Analysis file IO plugin for that package.

Figure 1-4. Calcium Interface in Cortex


Cortex - Jodi.cal - [Jodi_TwentyTwo2.cap]
File
Layouts
Data Views
Tools
Help
MotionAnalysis
Browse...
System
Calibration
Motion Capture
Post Process
Model Edit
Plugins
Presentation
Quick ID
Rectify
Create Template...
Template ID
Template Rectify
Marker ID
Exchange
Cubic Join
Virtual Join...
Calc VMs
Smooth
Make Unnamed
Rectify Unnamed
Delete Unnamed
Cut
Cut Outside
Search
PP Settings
Undo
Markersets
New
Add...
Jodi
Markers
TreeView
Jodi
Markers (41)
VMarkers (0)
Links (111)
SkB Segments (inactive)
Calcium Segments (66)
Root
M_BLHip
M_BRHip
M_FRHip
M_FLHip
Lumbar1
Lumbar2
Lumbar3
Lumbar4
Spine1
Spine2
Spine3
Spine4
Spine5
Neck1
Neck2
Neck3
Head
LClavicle
LUpperArm
LLowerArm
LWrist
LHand
LF11
LF12
LF13
LF21
LF22
LF23
LF31
LF32
1.434 (41+0)
VMs
Skeleton
Kinetics
1000
2000
3000
4000
5000
6000
7000
8000
1
1
Visible
Selected
0
1693
00:00:28:13
8240
8240
Selected
Visible
NONE
Calculate

Current Directory: C:\Program Files\Motion Analysis\Cortex2\Samples\Sky Examples

Name	Root
Index	1
Parent	GLOBAL
Translation	(-0.48, 0.89, -1.39)
Rotation Angle	0
Rotation Axis	(1, 0, 0)
Length	0.0405
Joint Type	Global
Attachments	4

24 - Loaded Capture: C:\Program Files\Motion Analysis\Cortex2\Samples\Sky Examples\Jodi_TwentyTwo2.cap | 8240 Frames | 60 FPS | Y-Up | Units:mm

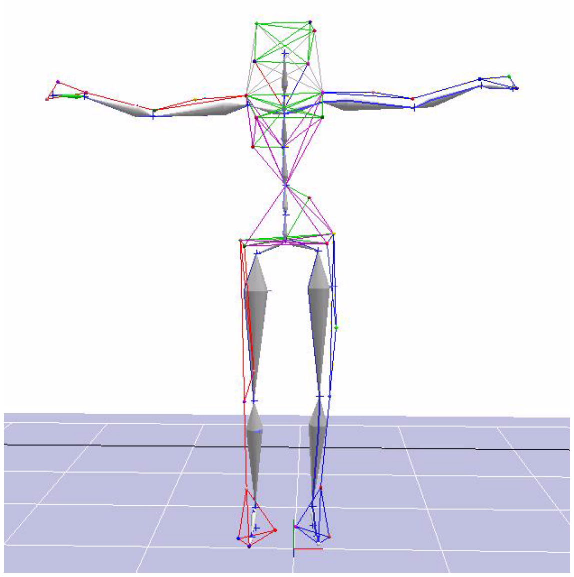
Note: Solver Interface (Si) is an older, stand-alone version of software that is similar in function to **Calcium**.

Skeleton Builder (SkB)

A skeleton, in animation terms, is a hierarchically connected set of bones with translation and rotation data. Each bone has a parent and potentially any number of children. One special bone has no parent and is usually referred to as the "root" of the skeleton. Skeleton Builder, as the name implies, is a tool that allows you to construct a skeleton by creating bones and arranging them in a hierarchy. Each bone is defined by the motion of three markers used to construct its rotation data. The Skeleton Builder interface is incorporated with the **Cortex** interface. Skeleton Builder is typically used in the Movement Analysis (Biomechanics) applications.

Skeleton Builder bone definitions are stored in the **Cortex** capture file. Any time you wish to save the definitions you have created simply save out a capture file. Various capture files are stored in the sample directory which contain the example skeleton at various stages of construction.

Figure 1-5. SkB Skeleton



Motion Composer

Motion Composer is a component of the **Cortex** interface which provides a seamless workflow for the user to package and present a motion capture session. This is done by loading data into **Cortex** and using Motion Composer to generate snap-shot slides of the data. The slides are stored and can be retrieved and interacted with at a later time. Some of the key features to be found in Motion Composer are described in the following sections.

Integrated Authoring

Motion Composer is an integrated part of **Cortex**. This integration allows new and existing users a seamless pathway from data collection to collation and presentation with a minimal learning curve. For current users, this integration leverages their existing knowledge of **Cortex**. Presentation output can be as simple as redirecting a **Cortex** capture to presentation format.

Interactive Player

Motion Composer ships with Motion Viewer, a freely distributable interactive player that enables customers to distribute their presentations quickly and easily. When it’s time to send research data to a colleague or take it on the road, authors can simply pack-and-go, turning their presentation into a single packaged ZIP file for quick burning to CD or emailing to a friend. With the interactive player inside, presentations are ready for launch on any Windows operating system.

Rich Media Support

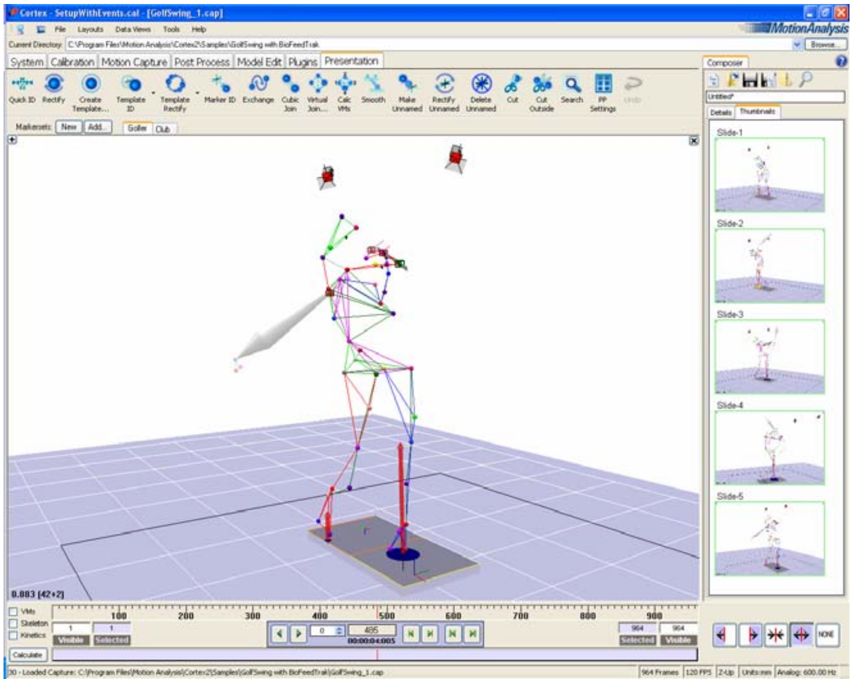
In addition to displaying capture data from **Cortex**, Motion Composer supports text and web-based media formats. This allows users to present data from third party applications. Examples would be text-based clinical notes, Microsoft Word documents, and HTML files. The following is a list of file formats which Motion Composer supports:

- Text (TXT, RTF, HTML, XLS)
- Reference Video (MPG, AVI)
- Images (JPG, GIF, BMP)
- Cortex Captures (CAP)
- User defined data types/views
- Presentation Graphs

Presentation Tools

The Motion Composer authoring interface provides a simple interface to easily manage a user’s disparate files, offering views of referenced files and slide thumb-nails. The Motion Composer authoring interface also makes it simple to create presentations. As data is added, the author uses Motion Composer’s one-touch slide generation to store the view as a slide. Presentation viewing becomes as simple as a slideshow.

Figure 1-6. Motion Composer Interface


Cortex - SetupWithEvents.cal - [GolfSwing_1.cap]
File
Layouts
Data Views
Tools
Help
MotionAnalysis
Current Directory:
Browse...
System
Calibration
Motion Capture
Post Process
Model Edit
Plugins
Presentation
Quick ID
Rectify
Create Template...
Template ID
Template Rectify
Marker ID
Exchange
Cubic Join
Virtual Join...
Calc VMs
Smooth
Make Unnamed
Rectify Unnamed
Delete Unnamed
Cut
Cut Outside
Search
PP Settings
Undo
Composer
Details
Thumbnails
Slide-1
Slide-2
Slide-3
Slide-4
Slide-5
Markersets:
New
Add...
Golfer
Club
0.883 [42+2]
VMs
Skeleton
Kinetics
100
200
300
400
500
600
700
800
900
Visible
Selected
NONE
Calculate

Current Directory: C:\Program Files\Motion Analysis\Cortex2\Samples\GolfSwing with BioFeedTrak

Untitled*

☐ VMs
☐ Skeleton
☐ Kinetics

Visible: 1 | Selected: 1 | 0 | 495 | 00:00:04:005 | Selected: 964 | Visible: 964

30 - Loaded Capture: C:\Program Files\Motion Analysis\Cortex2\Samples\GolfSwing with BioFeedTrak\GolfSwing_1.cap | 964 Frames | 120 FPS | Z-Up | Units:mm | Analog: 600.00 Hz

Digital Video Option (CortexDV Software)

The color Digital Video option allows you to record a time-matched Reference Video along with your motion capture trial on a separate computer. With this option, you will record a time-matched Reference Video AVI file with the same trial name in your motion capture folder. A separate computer is used in order to not burden your **Cortex** Host computer, which is an issue if your computer is too slow for the number of markers being tracked. For single person captures, you may connect the DV Camera directly to the **Cortex** Host computer. In this case, the **CortexDV** software is not needed as it is built into the **Cortex** software. You can run **CortexDV** on one or more computers and then capture multiple AVI files (multiple views). You may experience a small delay in frames from the **Cortex** software and the **CortexDV** software when capturing. This can be easily reconciled using the Adjust Frame Offset function (found in **Tools > Settings > Playback**), which allows for time-matching data streams.

Note: It is recommended that you start your digital video collection from pause mode (not in run mode) to minimize the potential for frame offset between the AVI and TRB files.

Software Packages Used with Cortex

The following are software products offered by Motion Analysis that are used in conjunction with **Cortex**. These files will require a license file and a separate installation package.

Animation Plugins

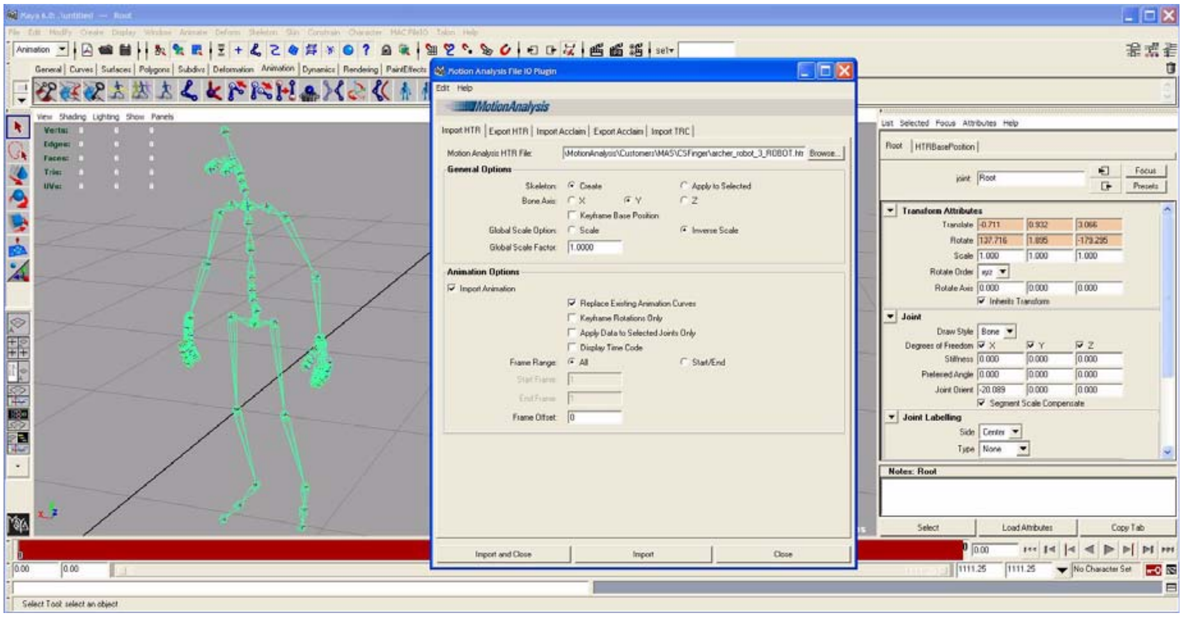
The MAC Animation Plugins, also known as the File IO Plugins, are used to read and write Motion Analysis motion capture files (TRC) into all of the major animation software packages including:

- Maya
- 3DS MAX
- Softimage XSI
- Lightwave
- Alias Motion Builder.

The Motion Analysis HTR file format is used for skeleton motion capture data. The Animation Plugins can take an existing character skeleton and export it to an HTR file (usually for use in Calcium) and it can take an HTR file created by Calcium and apply it to the character in the animation software.

The Motion Analysis TRC file format is used for tracked (markers) motion capture data. This data is generally only imported into the animation software. It is used for bringing in full body marker data, face data and prop data.

Figure 1-7. Animation Plugins Interface


Motion Analysis File IO Plugin
Edit
Help
MotionAnalysis
Import HTR
Export HTR
Import Acclaim
Export Acclaim
Import TRC
Browse...
Import and Close
Import
Close
List
Selected
Focus
Attributes
Help
Root
HTRBasePosition
Focus
Presets
Select
Load Attributes
Copy Tab
Select Tool: select an object

Motion Analysis HTR File: \MotionAnalysis\Customers\MAS\CSFinger\archer_robot_3_ROBOT.htr

General Options

Skeleton: ● Create ○ Apply to Selected
Bone Axis: ○ X ● Y ○ Z
☐ Keyframe Base Position
Global Scale Option: ○ Scale ● Inverse Scale
Global Scale Factor: 1.0000

Animation Options

☑ Import Animation
☑ Replace Existing Animation Curves
☐ Keyframe Rotations Only
☐ Apply Data to Selected Joints Only
☐ Display Time Code
Frame Range: ● All ○ Start/End
Start Frame: 1
End Frame: 1
Frame Offset: 0

joint: Root

Transform Attributes

Translate	-0.711	0.932	3.066
Rotate	137.716	1.895	-179.295
Scale	1.000	1.000	1.000
Rotate Order	xyz		
Rotate Axis	0.000	0.000	0.000

☑ Inherits Transform

Joint

Draw Style	Bone		
Degrees of Freedom	☑ X	☑ Y	☑ Z
Stiffness	0.000	0.000	0.000
Preferred Angle	0.000	0.000	0.000
Joint Orient	-20.089	0.000	0.000

☑ Segment Scale Compensate

Joint Labelling

Side: Center
Type: None

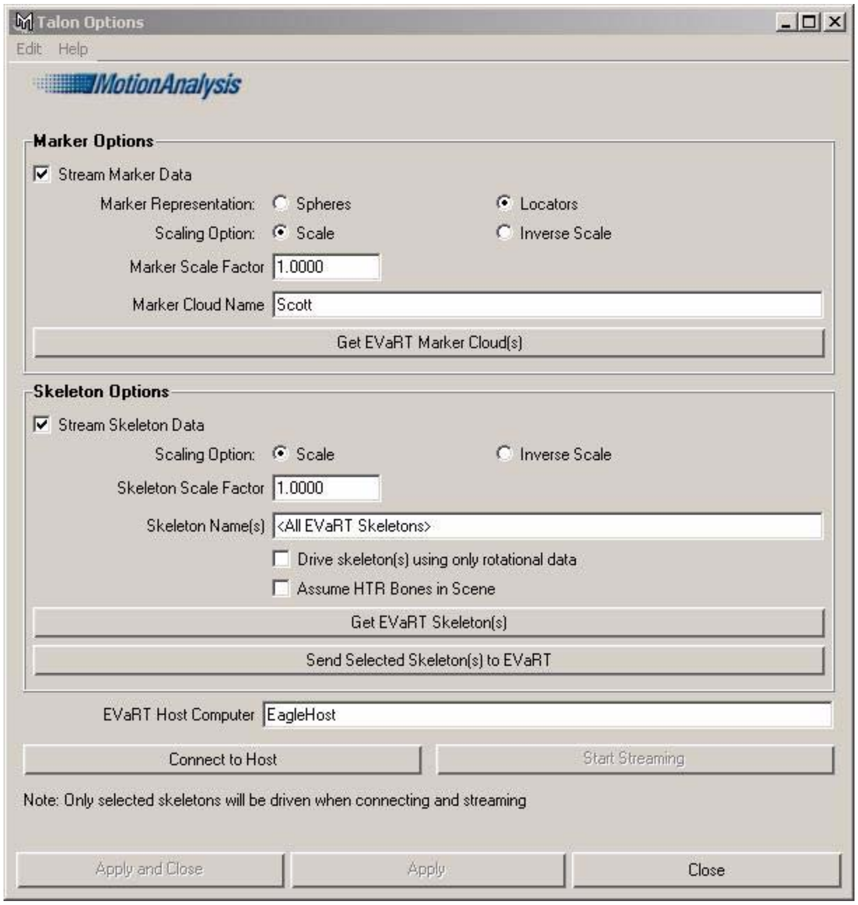
Notes: Root

Talon Plugins

The MAC Talon Plugins, also known as the Streaming Plugins, are used to stream data from a live, realtime connection in **Cortex** into an animation software package. Both skeleton and marker data can be streamed. This function is available for Maya, Motion Builder, and 3DSMAX. Additional animation packages are currently under development.

This same interface is used by outside developers to stream motion capture data into their own custom environments. This programming interface is called the SDK and is available upon request.

Figure 1-8. Talon Plugins Maya Interface


Talon Options
Edit
Help
MotionAnalysis
Get EVaRT Marker Cloud(s)
Get EVaRT Skeleton(s)
Send Selected Skeleton(s) to EVaRT
Connect to Host
Start Streaming
Apply and Close
Apply
Close

Marker Options

☑ Stream Marker Data

Marker Representation: ○ Spheres ● Locators

Scaling Option: ● Scale ○ Inverse Scale

Marker Scale Factor 1.0000

Marker Cloud Name Scott

Skeleton Options

☑ Stream Skeleton Data

Scaling Option: ● Scale ○ Inverse Scale

Skeleton Scale Factor 1.0000

Skeleton Name(s) <All EVaRT Skeletons>

☐ Drive skeleton(s) using only rotational data

☐ Assume HTR Bones in Scene

EVaRT Host Computer EagleHost

Note: Only selected skeletons will be driven when connecting and streaming

OrthoTrak

OrthoTrak is a completely integrated full-body gait analysis package designed for use in clinical and research studies of human locomotion. The system provides state of the art software designed to be used by clinicians in orthopaedics, neurology, and physical therapy, or for any person interested in assessing locomotor abilities of humans.

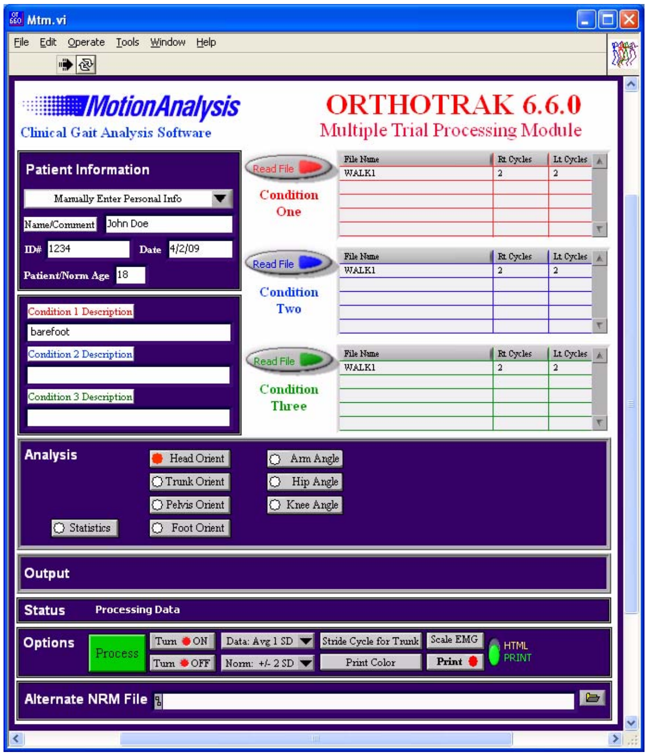
The system provides:

- quantification of 3D body, segmental, and joint motions
- analysis of the forces occurring in locomotion
- records of neuromuscular function through electromyography

Intended Use

OrthoTrak is designed primarily for analyzing a walking motion over level ground but can also be used for walking on treadmills, up and down stairs, or other activities. Gait data are presented in graphs which describe the kinematic (i.e. joint angles), kinetics (i.e. moments), and muscle activity (EMG). Data can be exported as industry-standard XLS data sets which can easily be imported into **Microsoft Excel™** or other graphics and analysis packages.

Figure 1-9. OrthoTrak Interface


Mtm.vi
File Edit Operate Tools Window Help
MotionAnalysis
Clinical Gait Analysis Software
ORTHOTRAK 6.6.0
Multiple Trial Processing Module
Patient Information
Read File
Condition One
Read File
Condition Two
Read File
Condition Three
Analysis
Output
Options
Process
Stride Cycle for Trunk
Scale EMG
Print Color
Print
HTML
PRINT
Alternate NRM File

Manually Enter Personal Info

Name/Comment: John Doe

ID# 1234

Date 4/2/09

Patient/Norm Age 18

Condition 1 Description: barefoot

Condition 2 Description:

Condition 3 Description:

File Name	Rt Cycles	Lt Cycles
WALK1	2	2

File Name	Rt Cycles	Lt Cycles
WALK1	2	2

File Name	Rt Cycles	Lt Cycles
WALK1	2	2

Analysis:
● Head Orient
○ Trunk Orient
○ Pelvis Orient
○ Foot Orient
○ Arm Angle
○ Hip Angle
○ Knee Angle
○ Statistics

Status: Processing Data

Turn ● ON
Turn ● OFF
Data: Avg 1 SD
Norm: +/- 2 SD

SIMM

SIMM (Software for Interactive Musculoskeletal Modeling) is a software system that enables you to create and analyze graphics-based models of the musculoskeletal system. In **SIMM**, a musculoskeletal model consists of a set of bones that are connected by joints. Muscle-tendon actuators and ligaments span the joints. The muscles and ligaments develop force, thus generating moments about the joints.

SIMM allows you to analyze and test a musculoskeletal model by calculating the moment arms and lengths of the muscles and ligaments. Given muscle activations, the forces and joint moments (muscle force multiplied by moment arm) that each muscle generates can be computed for any body position. By manipulating a model on the computer graphics system, you can quickly explore the effects of changing musculoskeletal geometry and other model parameters.

Since the software can be used to study many different musculoskeletal structures, it can enhance the productivity of investigators working on diverse problems in biomechanics. **SIMM** provides a framework that organizes the parameters of a model and allows people to work together on a modeling project. The moving, three-dimensional images of anatomical structures that you can create are extremely valuable when developing a model and when communicating the results of an analysis.

Applications

SIMM has a wide variety of applications. A few examples include the following.

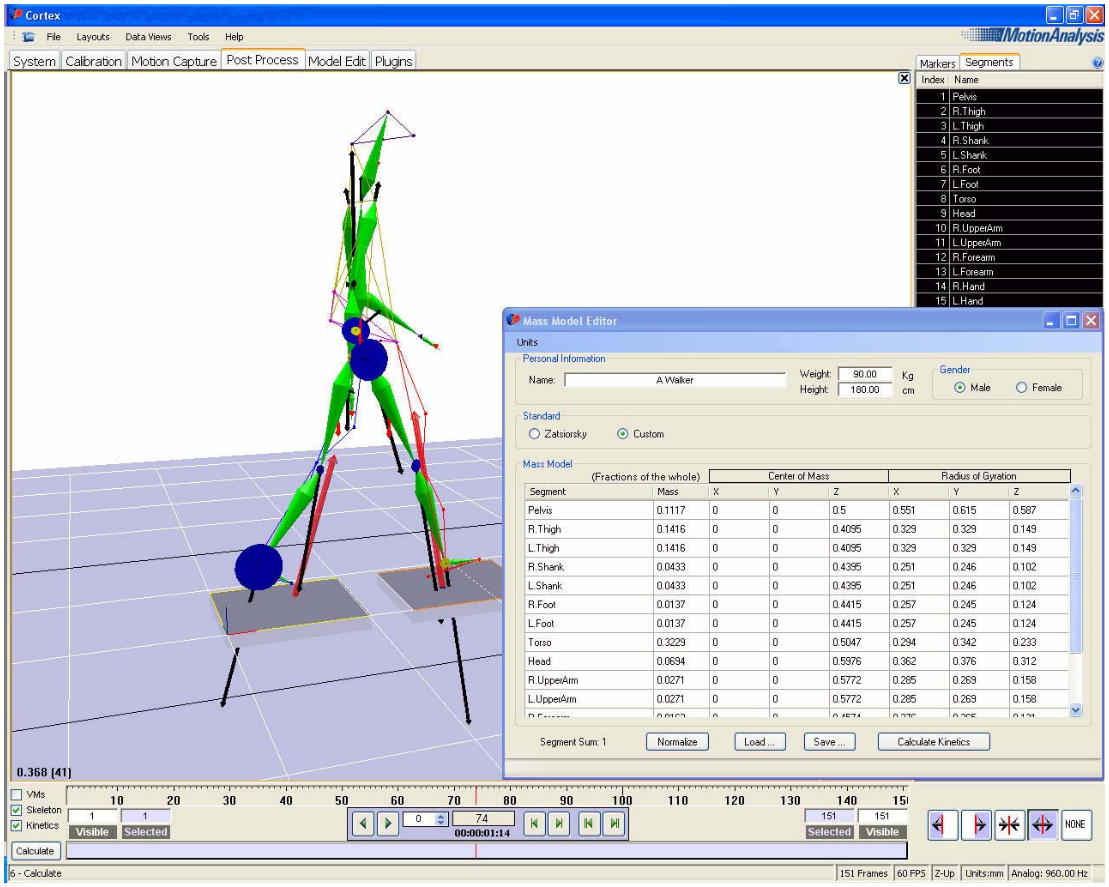
- Biomechanics researchers are using **SIMM** to create models of the human elbow, wrist, jaw, and other anatomical structures. These models can be altered according to particular surgical procedures to study how the surgical alterations affect muscle function. SIMM can also be used to analyze and display the mechanics of injuries.
- Neuroscientists are using **SIMM** to study how the central nervous system controls movement. For example, muscle activation patterns determined from electromyographic recordings can be used to estimate muscle forces and joint moments generated during a task. The computed joint moments can then be compared to experimentally recorded moments.
- Medical students and residents can use models created with **SIMM** to study musculoskeletal anatomy and function. In addition to visualizing anatomical structures, students gain an appreciation for the interplay of muscle architecture and joint geometry.
- Kinesiologists who record and analyze the motion of persons with movement disabilities can use **SIMM** to create three-dimensional animations of a person's movement. Movements, such as walking, can be quantitatively compared to normal movement to gain insight into the causes of movement deformities. Motion can also be analyzed in the context of optimizing athletic performance.
- Human factors engineers who need to account for muscle strengths when designing products or work stations can use **SIMM** to study how posture effects muscle strength. Limits on joint ranges of motion can also be taken into account.
- Biologists interested in animal movement can create models to quantify limb function. Investigating movement strategies in other species can provide insights needed to design machines that move.

- Computer scientists who develop models of the human body for virtual environments can use **SIMM** to create the models and compare them with biomechanical data for verification.
- Animators can use **SIMM** to develop realistic representations of human and animal movements. World objects can be added to provide a context for the animation.

KinTools RT

KinTools RT is a full-body, three-dimensional engine capable of calculating kinematic and kinetic information from models that are created and saved in the capture file(s). The kinetic calculations can be done on either of the two skeleton types available in Cortex: Skeleton Builder and Calcium. The Skeleton Builder models are generally simpler to use as they automatically scale the bone lengths to the subject's actual bones. The Calcium based models use an the entirely different computation method of Global Optimization. With either skeleton type used, the end results are similar.

Figure 1-10. Cortex KinTools RT Interface


Cortex
File
Layouts
Data Views
Tools
Help
MotionAnalysis
System
Calibration
Motion Capture
Post Process
Model Edit
Plugins
Markers
Segments
0.368 (41)
10
20
30
40
50
60
70
80
90
100
110
120
130
140
150
Visible
Selected
00:00:01:14
NONE
Calculate
6 - Calculate
151 Frames
60 FPS
Z-Up
Units:mm
Analog: 960.00 Hz
Mass Model Editor
Units
Normalize
Load ...
Save ...
Calculate Kinetics

☐ VMs
☑ Skeleton
☑ Kinetics

Index	Name
1	Pelvis
2	R.Thigh
3	L.Thigh
4	R.Shank
5	L.Shank
6	R.Foot
7	L.Foot
8	Torso
9	Head
10	R.UpperArm
11	L.UpperArm
12	R.Forearm
13	L.Forearm
14	R.Hand
15	L.Hand

Personal Information

Name: A Walker

Weight: 90.00 Kg

Height: 180.00 cm

Gender: ● Male ○ Female

Standard: ○ Zatsiorsky ● Custom

Mass Model

	(Fractions of the whole)	Center of Mass			Radius of Gyration		
Segment	Mass	X	Y	Z	X	Y	Z
Pelvis	0.1117	0	0	0.5	0.551	0.615	0.587
R.Thigh	0.1416	0	0	0.4095	0.329	0.329	0.149
L.Thigh	0.1416	0	0	0.4095	0.329	0.329	0.149
R.Shank	0.0433	0	0	0.4395	0.251	0.246	0.102
L.Shank	0.0433	0	0	0.4395	0.251	0.246	0.102
R.Foot	0.0137	0	0	0.4415	0.257	0.245	0.124
L.Foot	0.0137	0	0	0.4415	0.257	0.245	0.124
Torso	0.3229	0	0	0.5047	0.294	0.342	0.233
Head	0.0694	0	0	0.5976	0.362	0.376	0.312
R.UpperArm	0.0271	0	0	0.5772	0.285	0.269	0.158
L.UpperArm	0.0271	0	0	0.5772	0.285	0.269	0.158

Segment Sum: 1

For More Information

Please contact Motion Analysis Customer Support with any questions, problems, or feedback about the Motion Analysis **Cortex** software. We can be reached at:

Motion Analysis Corporation
3617 Westwind Blvd.
Santa Rosa, CA, USA 95403

Phone: 707-579-6500
Fax: 707-526-0629

http://www.motionanalysis.com

For technical support and licensing information, please contact:

support@motionanalysis.com

For information about sales, please contact:

info@motionanalysis.com

Acknowledgments

Thank you to the users and Beta testers listed in **Help > About Cortex**.

Chapter 2

Planning a Motion Capture Session

Topic	Page
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Job Assignments and Tasks During the Session	2-3
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Overview

The motion capture process starts by collecting raw video data of the subject. The success of the final motion data will depend not only on the quality of the subject's performance but also on the organization skills and experience of the **Cortex** operator. The quality of the **Cortex** data can be greatly affected by the events leading up to and during the motion capture session.

An efficient motion capture session can ultimately save time and money. Although this chapter is geared towards animation, some information may be helpful for both animation and biomechanics. What follows are suggestions that can help make the motion capture session run smoothly.

Studio or Lab Preparation

At least a day before the capture session, the **Cortex** user should know the capture volume required and the nature of the motion capture project. This information is essential for an efficient motion capture session. Knowing the capture volume allows for the advanced selection of the appropriate marker size for the session.

It may be appropriate to use different capture volumes for the different moves of a capture session. Changing the capture volume size and optimizing this volume could take up to one hour, so this switchover should be scheduled during a break. The approximate volumes can be set up ahead of time using tape on the floor to mark the capture volume boundaries and the position for the tripod legs (if used) of each camera.

If more than one subject will be performing in a capture session, it is a good idea to mark out a capture volume practice area away from the actual capture area. This will allow the next subject to practice before motion capture.

On the **Cortex** host workstation, create the appropriate directories and capture files. For batch edit work in Post Processing, a separate file folder for each capture and its associated capture files is strongly suggested.

Make sure there is enough room on the **Cortex** workstation’s hard disk. If you know the number of trials you are going to capture and the approximate length of each trial, you can estimate the amount of hard disk space you will need. Use some form of backup medium (e.g. CD-ROM, Zip disk) to back up previous data and clear space on the hard disk for the new trials.

Prior to the Capture Session

Several days prior to the capture session, schedule a visit by the subject and any producers or directors involved in the motion capture session. If the subject has not worked with reflective markers, this will allow time to become familiar with marker placement and to practice in the marked-out capture area.

You will want to specify the most desirable type of clothing for the session. Remember, your goal is to capture the fine details of the movement of the body, not the movements of clothing on the body. The rule is to apply markers to skin whenever possible. The areas on the body that present the greatest potential problems are shoulders, the rear neck, sternum, mid back, and the root. A tank-top shirt may be used to expose the shoulder, neck, and sternum. The root marker should be placed low on the spine in an area below the belt line where there is usually very little clothing movement. If a mid back marker is used, the shirt should be rolled up and taped to expose the back. If skin cannot be exposed for all marker placements, then tight fitting clothes or a motion capture body suit should be worn.

Have the subject perform some of the motion capture moves within the capture area. If markers have been placed on the subject, go ahead and capture some data. This would be an ideal opportunity to use a stopwatch to time the duration of each move. These trials can give the **Cortex** user an indication of potential tracking problems, and if this data is taken all the way to the animation software, it will allow the artist to see how well the data fits their models.

Finally, instruct the subject to speak up during the motion capture if there are any problems with the markers. If markers become loose, they will need to be reconnected more securely with tape or rubber bands.

Job Assignments and Tasks During the Session

Director

The director ensures that everyone involved is prepared for the capture session and controls the session, including instructing and critiquing the subject's performance.

Camcorder Operator

The video recording from the camcorder can be very important documentation to aid in choosing the best takes. A video recording may also be useful for post-production promotions. An optional reference video capture is available. Refer to "Digital/Reference Video Option (CortexDV Software)" on page 4-70.

The camcorder should not be allowed to run during the entire capture session. This means that someone should be assigned to start and pause the camcorder for each take.

The camcorder operator should slate each of the takes. This involves recording the take number, the **Cortex** trial name and number, and any other relevant information on a slate board. After starting the camcorder and before each take, the slate board is held up in front of the camcorder for a few seconds. The audio on the camcorder can also be used. When the slate is held up in front of the camcorder the operator can say the take number, the **Cortex** filename, and any other information necessary. When the take is complete, the director can make audio comments on the quality of the take.

Scribe

Someone should be assigned to take notes and to fill in the Motion Capture Log. A sample of this log is found in Appendix I, Useful Blank Forms.

The take number, **Cortex** file name, and the duration of the take and any comments from the director or subject should be recorded. The scribe can also do a time check using a stop watch to get the length of data capture for each new move.

Cortex Operator

The **Cortex** operator must make certain that the motion capture data is clean and trackable. The **Cortex** operator must make sure the camera calibration is good and that raw calibration data is collected at various times throughout the session as insurance. This is particularly important when there are several people around and a camera might get bumped accidentally. The operator should watch for reflections, changing light conditions, such as sunlight coming through a window, or other external variables which may affect a capture.

Additional Equipment

Props

If the motion capture session requires the use of props, this must be known to all parties well in advance. The type of prop and its use are very important because reflective markers may have to be attached to the prop as well as the subject. One marker may be used to track position, but as many as three markers may be required to show all rotations of the prop. Many props that would ordinarily seem simple become very difficult to deal with during a motion capture session. A good example is the use of a ball as a prop. If a small ball is only being held, one marker may be used to track position. If a large ball is being bounced, three markers may be required to show all rotations.

Reflective or glossy material should **not** be used in the construction of props, and very large props may occlude the subject's markers. Remember, the design of the prop and how it affects the subject's movement are more important than the prop's physical appearance. Props may also be assigned separate templates.

Camcorder

Used to completely document each trial, a camcorder will allow the producer to rank the trials of a move and will also give the animation artist something to use as a reference for the completed animation. See also "Digital/Reference Video Option (CortexDV Software)" on page 4-70.

Still Camera

Photographs of the subject, with markers attached, will help the artists understand the correspondence between the marker data and the actual figure.

Slate Board

A slate board and chalk or grease-pen board will provide an easy way to relate the camcorder record to the **Cortex** data.

Markers, Tape, Pre-tape Liquids, Rubberbands

An adequate supply of reflective markers, double stick tape, paper tape, and "Tuff Skin" or "New Skin" should be available. For rough and tumble sessions, the best method to adhere markers is by using Velcro™ on a skin-tight motion capture suit. However, markers can be applied directly the skin.

If markers must be placed directly on the skin and the subject will be performing athletic moves in which perspiration might be a problem, pre-tape liquids like "Tuff Skin" or "New Skin" can help make double-stick tape adhere better. These products must be applied to dry skin and allowed to set for a minute or two before the marker is attached.

Rubberbands looped around the marker and limb also work well to stabilize the markers. Rubberbands can be looped together to increase diameter and prevent restriction of blood flow. Rubberbands can be used around the elbows, wrists, hands, knees, ankles and toes.

Backup Media

Spare CD-ROMs, Zip disks, or some other backup medium should be available for backups and data transfers.

Motion Capture Body Suit

A motion capture body suit with Velcro attachments for markers provides a quick way to prepare a subject for motion capture. The use of the body suit is especially effective when subjects are involved in rough or contact-type motion capture sessions, common in animation applications.

Camcorder Tapes

Depending on the length of the capture session, spare video tapes should be on hand.

Music Player

Either a CD or tape player can provide musical accompaniment. Music helps calm and smooth out the subject's performance not only with dance, but athletic moves as well.

Stop Watch

A stop watch is handy for calculating the duration of each new move.

Sample Form

You should decide at the outset whether you will build a hierarchical skeleton. If you decided to, there are two software methods available: **SkB (Skeleton Builder)** and **Calcium.**

Blank forms to help you define skeleton parameters for each of these methods can be found in Appendix I, Useful Blank Forms. You may want to copy one of these forms for recording your project measurements.

Motion Capture Terminology

Some terms that are useful to a motion capture session are **moves, trials,** and **takes**.

Move

A **move** is an event or routine performed by the motion capture subject. A move can be as simple as a neutral stance position, or as complex as a 2 person, 30 second dance routine. The director and subject will work from a **move list**.

Capture or Trial

Multiple **captures** or **trials** of a move should be taken. The number of trials depends on the complexity of the move, the subject's performance, and quality of the **Cortex** raw data. Usually, three trials per move is adequate. It is important that the director or subject's comments about the quality of the trial (which trial was the best) be recorded on the Motion Capture Log. Knowing which trial of a move is the best will allow the **Cortex** user to track only the best trial.

Take

A **take** is the master number used to relate what is on the camcorder's video tape to the **Cortex** filenames and trial numbers. The **take number** is displayed on the slate board and on the Motion Capture Log. Every new image recorded on the video tape should have a new take number. This should include calibration collection, initialization and T-pose/Init pose stance positions. You should never re-use or redo a take number. If a data collection is aborted for some reason, e.g. a marker fell off, then the **Cortex** filename and trial number can be overwritten, but the take number should change.

Motion Capture Session Sequence of Events

The Day Before:

1. Optimize the camera positions and orientation to the capture volume.
2. Calibrate the volume of the capture area.
3. Determine the correct marker size to use. **Cortex** raw data should show 2 lines or greater per marker.
4. Setup the **Cortex** capture with the correct markers, virtual markers, linkages, segments, etc.
5. If possible, collect and track the markers on a person to verify that the tracking parameters are optimal.
6. Verify that there is enough space on the workstation's hard disk. If there is not enough space, back up the previous files and then erase them from the hard disk.
7. Organize the markers, tape, and props to most efficiently facilitate the session.

The Day of the Motion Capture

Before the subject arrives:

1. Load the **Cortex** capture file.
2. Optimize the threshold settings.
3. Collect calibration data sets (both seed and wand).

Subject Preparation

1. Ensure subject's clothing is appropriate.
2. Allow the subject to warm up.
3. Attach the markers according to predetermined placements.

Note: Asymmetrical marker placement on the subject is critical for obtaining the best marker data.

4. With the markers in place, take still photos of the subject from the front, side, and rear view.

Note: If you are taking photographs, do not use the flash attachment on the still camera while you are collecting data. A flash during data collection can corrupt the data.

5. Allow the subject to practice in the capture volume with the markers on.
6. Prepare for the calibration collection. Explain to everyone the importance of not bumping the camera tripods.

Capturing the Data

Calibration

Note: This section provides a general overview of the calibration process.

Collect the Square (Seed) Calibration

1. Fill out the Motion Capture Log and slate board for the first square (seed) calibration. This would be Take 1 and an **Cortex** filename, for example “**CalSeed**”.
2. Prepare the **Cortex** system for data collection. Press the **Collect and Calibrate** button to trigger the event button.
3. Verify that the camera buttons turn yellow after the Seed calibration is complete.
4. Remove the calibration seed device (calibration L-frame) from the capture volume.

Collect the Wand Calibration

For best results it is recommended that you collect and use wand calibration data.

Prepare the **Cortex** system for wand calibration. The duration of the wand calibration is directly correlated to the capture frame rate. A typical duration for a small capture volume is 30 to 60 seconds. Large volumes with ten or more cameras can take 120 to 180 seconds, and very large volumes may take up to 240 seconds.

Collect and verify that the wand calibration data is good. It may be necessary to reposition or move cameras and to retake both the seed and the wand calibration data if one or more cameras has large areas without wand calibration data. You can continue pressing **Run** after it finishes, until the calibration numbers stop changing.

Your wand data should cover the entire capture volume. A common method of ensuring better wand data is to use a 1/3 method. That is, hold the wand markers in alignment along each axis (X, Y, and Z) for 1/3 of the wand capture session.

Collecting Captures

Subject Initialization

The type of subject initialization depends on the application.

- In animation applications it is the “T-Pose” or “Init Pose” trial
- For **OrthoTrak** it is the Static Trial

In general, the procedure is as follows:

1. Have the subject stand in the capture volume with the markers on. On the **Cortex** system. Look for any reflection and light source that might interfere with the capture and correct the problem.

2. Prepare the **Cortex** system by entering a filename. If the subject's name is Jane use something like JaneInit. For this initialization file, use a duration of 2-3 seconds. The take number should be set to 3. Click on **Collect** to arm the event button. You can enter a long duration (e.g. 20 seconds) and then press the hand-held event button a second time at the end of the move.
3. Update the slate board with the new take number and **Cortex** filename. Make the same entries in the Motion Capture Log.
4. When everybody is ready, the director can say "roll video", then slate the video. Now the **Cortex** operator gives the signal for the subject to start and presses the event button to start the data collection. The event button must be pressed a second time to stop data collection at the end of the move.
5. For initialization, use the T-pose/Init pose. In this pose the subject faces forward and raises both arms straight out from their sides with the thumbs oriented up. Perform this motion within the duration of the capture time.
6. Pause the camcorder.
7. Collect two trials of this "initialization" move.

Capturing the Moves

1. Before capturing, have the subject practice each move.
2. Enter a duration **longer** than the estimated length of the move.
3. Enter an **Cortex** filename, the duration of data capture, the trial number and trigger the Event button.
4. Update the slate and the Motion Capture Log.
5. The director should ask if everybody is ready and then say:
"Roll video", "Slate video."
6. The **Cortex** operator presses the event trigger button and the subject begins the trial. When the trial is finished, the event trigger button is pressed again to complete the capture.
7. Comments on the quality of the trial should be entered into the Motion Capture Log and on the audio of the camcorder.
8. The **Cortex** operator quickly reviews the raw data and looks for any problems.
9. This process is usually repeated for 3 trials of each move that is scheduled.

Note: Usually only one trial is tracked. The other trials are there for insurance and to allow the end user to pick the best trial.

Collecting Calibration "Insurance" Data

For insurance, it is a good idea to periodically collect raw calibration data whenever there is down time. As the number of people increases in the capture studio, the chance for bumping a camera (if tripods are being used) increases and "insurance" calibration data suddenly becomes very valuable.

Wrapping It Up

After all the trials have been collected, perform the following to wrap up the process:

1. Collect the last calibration trial.
2. Backup all the **Cortex** trials on a CD-ROM, external hard-drive, or other backup medium. Label and store the tape in a safe place.

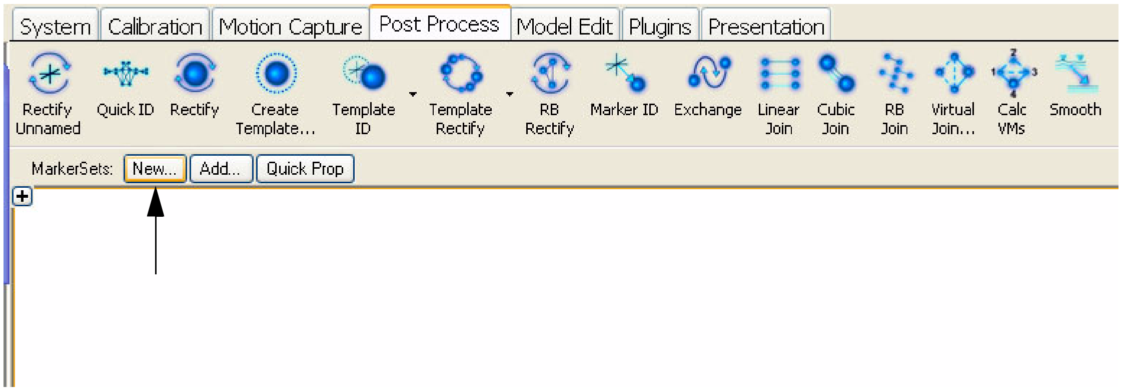
3. Remove the video tape from the camcorder and set the safety tabs on the tape to prevent being recorded over.
4. Consolidate and make copies of the motion capture logs and forms.
5. If necessary, give the video tape and Motion Capture Logs to the director so the best trials of each move can be indicated.
6. Place logs and offset forms in a binder. Clear plastic inserts can be added to hold the still photos. The binder along with the video tape will provide important information to both the **Cortex** user tracking and editing the data, and for the artists who will apply the final data to the model.

Creating a New MarkerSet in Cortex

The following steps are to give the MarkerSet a name, input the marker names, capture a trial, identify and edit the data, create linkages, create a template and finally save the MarkerSet name.

1. Click on **Post Process > MarkerSets Tab > New...** and give the MarkerSet a name. Check Identifying Template MarkerSet. (Props are for single rigid objects like tennis rackets or golf clubs).

Figure 2-1. MarkerSet Tabs


System
Calibration
Motion Capture
Post Process
Model Edit
Plugins
Presentation
Rectify Unnamed
Quick ID
Rectify
Create Template...
Template ID
Template Rectify
RB Rectify
Marker ID
Exchange
Linear Join
Cubic Join
RB Join
Virtual Join...
Calc VMs
Smooth
MarkerSets:
New...
Add...
Quick Prop

2. Select **Model Edit > Markers** and type in the new marker names. Order them so that the highest markers are at the top of the list) Capture a trial then load the last capture.
3. Quick ID to Identify the markers, edit if needed (use caution to avoid any marker switches or mistakes in making the Template).
4. In the **Model Edit > Markers** tab, create linkages for the template. Click and drag in the 3D views to make the linkage lines between the markers. For best automatic identification, use rigid triangles where possible. Connect things that are close and don't move much with respect to each other.
5. Click on **Create Template...** Check **Show Template Linkages**. Use a frame range as large as possible where there are no mistakes. Check **Include current frame as the Model Pose** if you want to use this as the "New Subject.." identifying template for new persons.
6. Select **Save MarkerSet As...** and give it a name. It will be saved as a .mars (MarkerSet) file. Save it in the current folder.

7. Copy it to the "System Objects" folder. If you want to use the MarkerSet in other folders, make a copy as follows:

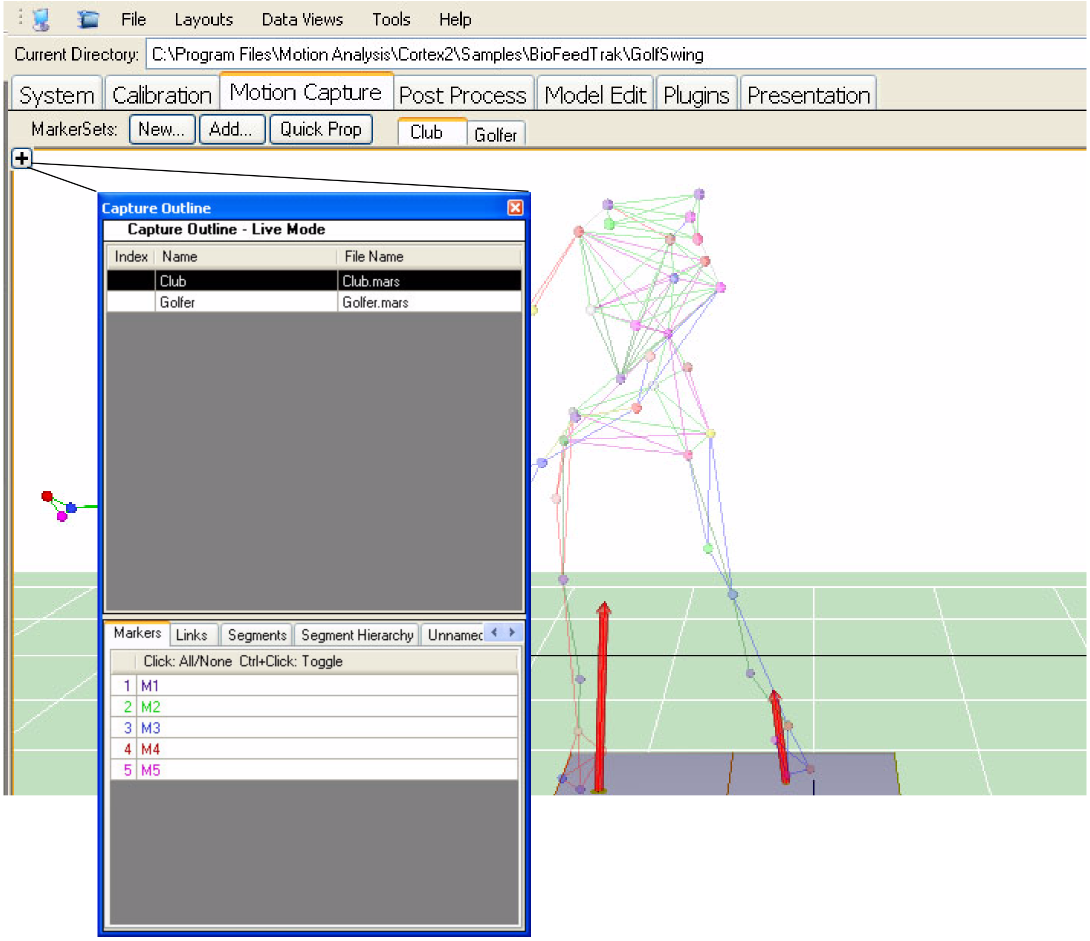
In the Motion Capture > Object panel, select the MarkerSet name and use the blue DOWN arrow. You will see a copy in the "System Objects" folder.

8. Using the new MarkerSet in a new folder: Load an existing Setup from your last Capture. Select **Save Setup As..**. and make a new folder. From the **Motion Capture > Objects** panel, select your (new) MarkerSet from the "System Objects" panel, use the blue UP arrow to copy that to the current (Local Objects) folder.

Note: You can also make a skeleton for this MarkerSet which can be either a Skeleton Builder or Calcium type skeleton and that can have a Mass Model associated with it.

Capture Outline - Live Mode

Figure 2-2. Capture Outline - Live Mode Interface


File
Layouts
Data Views
Tools
Help
System
Calibration
Motion Capture
Post Process
Model Edit
Plugins
Presentation
MarkerSets:
New...
Add...
Quick Prop
Club
Golfer
Capture Outline
Markers
Links
Segments
Segment Hierarchy
Unnamed
Click: All/None Ctrl+Click: Toggle

Current Directory: C:\Program Files\Motion Analysis\Cortex2\Samples\BioFeedTrak\GolfSwing

Capture Outline - Live Mode

Index	Name	File Name
	Club	Club.mars
	Golfer	Golfer.mars

1	M1
2	M2
3	M3
4	M4
5	M5

How to Rename a Capture in Cortex

If you have made a mistake in the naming of the capture, the easiest thing to do is to save the capture with a new name. Trying to rename all of the files associated with the capture is laborious and error prone. But, if you use the Save Capture As... dialog, Cortex does not re-write all of the files with the new capture names. It will re-write the tracks file(s) but not the "Raw" Video Camera (VC) files or the AVI files. To be sure all files are rewritten, use the **File > Trim Capture W/Options** menu item and use either "Save all Frames" or "Save Selected Frames" to make the capture smaller. This forces Cortex to re-write all of the files with the new names. Be sure to check all of the output files you want saved and these check boxes will get remembered next time you launch Cortex. Then you can delete the old capture files.

Only after you are sure the new files can be loaded into Live (Motion Capture) and Post Processing modes, then use Windows Explorer to highlight and delete all of the files and folders with the wrong capture name. Note that the default is to have the "Raw VC files" stored in separate folders under the VCFiles folder, so you should see the wrong capture folder names in the VCFiles folder that can be removed.

Chapter 3

Camera Setup

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Raptor-4, Raptor-E, Eagle-4 and Eagle Series Camera Physical Dimensions	3-16
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Setting Up a Motion Capture Laboratory

Camera placement is the most important aspect of setting up your motion capture laboratory. If properly done, good camera placement will reward you with highly accurate and consistent results, and greatly reduced editing time.

Optimum Laboratory Conditions

- Fluorescent lights are the best ambient light when red or notch filters are used on the motion capture cameras.
- Windows should be covered with curtains to eliminate direct outside light.
- Carpeting or other non-shiny floor surfaces are preferable to tile flooring which can reflect opposing ring lights.

Recommended Supplies

- A stepladder—for adjusting the cameras/tripods.
- Masking tape—to mark the floor when measuring the capture space and setting up the cameras.
- Reflective markers—to attach to the subject and also enough to place on the floor when adjusting the cameras.
- Other supplies include surgical tape, electrode collars for applying markers to people and gaffer’s tape (black masking tape).

Deciding On the Optimum Number of Cameras

There are several objectives to consider when deciding how many cameras should be used and where they should be placed.

1. There should be a sufficient number of cameras to insure that, at all times, all markers will be visible by at least two, and preferably three, cameras. In general, the number of cameras must be increased when:
    - the motion of the subject becomes less constrained
    - the number of subjects or objects increases
    - the capture volume increases
2. As more cameras are used, each camera should view only a portion of the capture volume to achieve higher accuracy and prevent too many cameras from seeing any one marker. For large capture volumes with a large number of cameras (10+), it is recommended that all 4 markers on the calibration L-frame are seen in only 1/4 to 1/2 of the cameras. You can then use the Extend Seed function (see "Extending the Seed Calibration" on page 6-20) to calibrate the remaining cameras.

Note: When more than 5 or 6 cameras see the same marker, the accuracy of tracking is not increased and computation time increases.

3. Camera views should not include areas outside the capture volume to ensure the highest possible spatial resolution.

The number of cameras in a typical motion capture setup can be as few as 2 or as many as 250. The following provides some guidelines for deciding on the number of cameras to use. In the following figures, all measurements are in meters.

6 Cameras

For motion capture involving only one subject, where the occlusion of markers is not a problem, six cameras may be adequate. This configuration is often used for gait analysis and other similar biomechanical applications. The two end cameras are often tilted so that the long axis of the view areas is vertical. For optimum results, all cameras should be about 2.5 meters above the floor. See Figure 3-3.

8 Cameras

As a wider range of motion is allowed, the probability of markers being occluded increases to the point that eight or more cameras are required. This is the minimum recommended configuration for animation applications. Cameras should be about 3 meters above the floor. See Figure 3-4.

10 Cameras

In an elongated capture space, ten cameras may prove beneficial. The first 8 cameras should be placed about 3 meters above the floor as in the 8 camera setup. The two additional cameras (9 and 10) should be placed 5 meters above the floor at each end of the long dimension of the capture volume and will probably have longer focal length lenses than the other cameras. See Figure 3-5.

12 Cameras

As the capture volume becomes more elongated, twelve cameras may be required. The first 8 cameras should be placed 3 meters above the floor. Cameras 10 and 11 should be placed as 5 meters above the floor on the ends of the capture volume but closer to the center than cameras 9 and 12 (same height). Therefore, one end of the long volume will be covered best by cameras 9 and 11, while the other end will be covered best by cameras 10 and 12. See Figure 3-6.

14 Cameras

When the sides of the capture volume are too long to be adequately covered by four cameras on each side, an additional pair of cameras with wide angle lenses can be placed in the center of each long side of the capture volume. The first 8 cameras should be 3 meters above the floor. Cameras 9 through 14 should be 5 meters above the floor. See Figure 3-7.

16 Cameras

To use more than 14 cameras effectively, it is usually necessary to break the capture volume into two overlapping sections across the long axis. Every camera must see at least one of the squares in its entirety. All cameras should be placed at least 3 meters above the floor. See Figure 3-8 on page 3-8.

For more information and an example, refer to “Overview of the System Calibrating Process” on page 3-18.

More than 16 Cameras

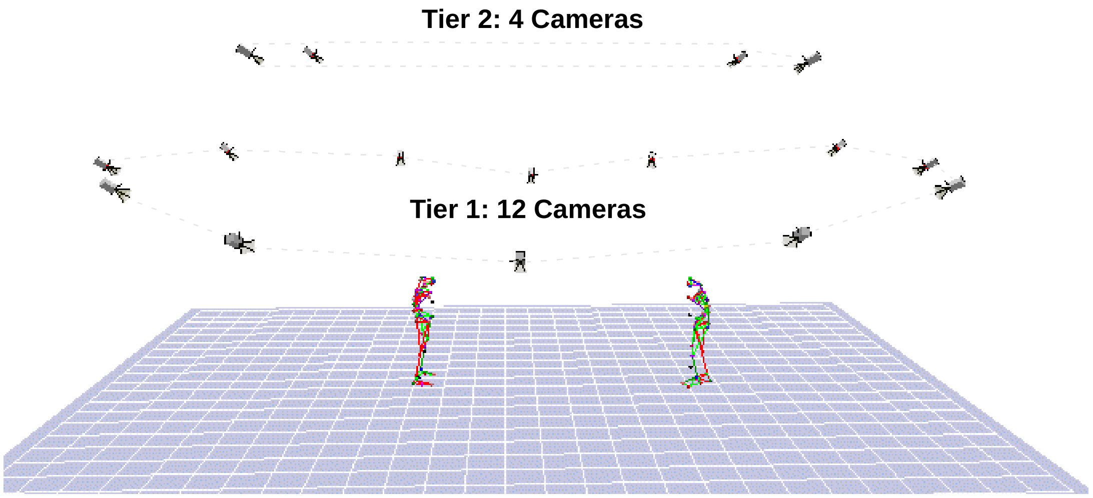
As capture volumes increase in size, more than 16 cameras may be required. It is best to consider the capture volume as two or more overlapping regions. For large square shaped capture volumes, up to 32 cameras can be used with the space broken into four regions. See Figure 3-9.

Capture Volumes Between Motion Analysis Cameras

Motion Analysis cameras use the same high-powered ringlights and have the same limits for marker distances. The difference between the cameras is that you can use smaller markers with the Raptor-4, Raptor-E, Eagle-4 and Eagle cameras (about one-half the size of the Raptor-H and Hawk markers). A typical example would be 1/4 inch (6 mm) markers for Eagle cameras and 1/2 inch (12.5 mm) markers for Hawk cameras.

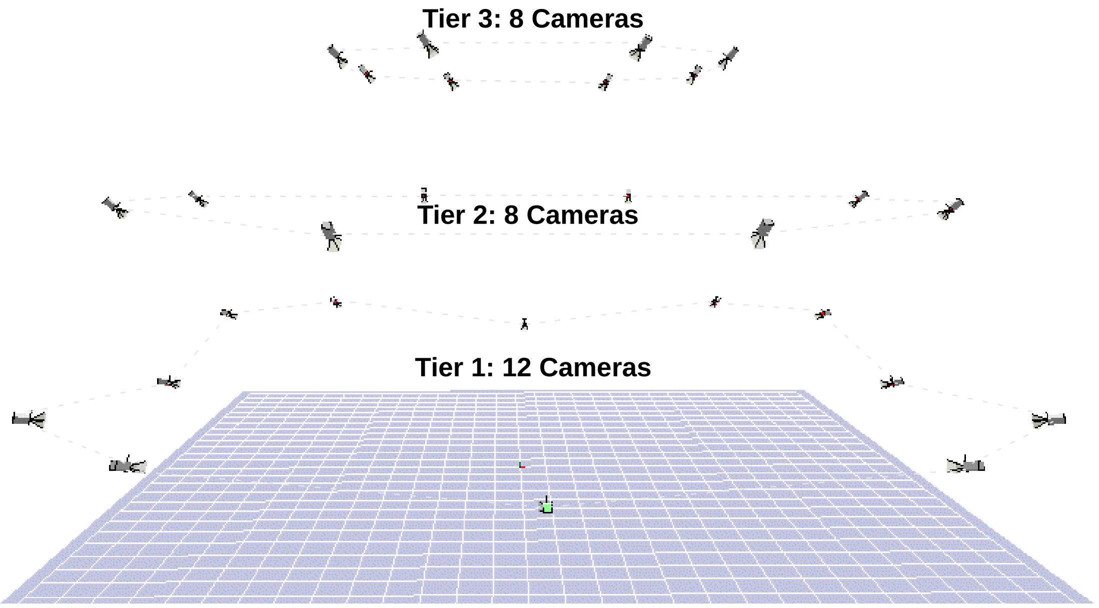
16 Camera, Two-Tier Setup

Figure 3-1. 16 Camera, Two-Tier Setup


Tier 2: 4 Cameras
Tier 1: 12 Cameras

28 Camera, 3-Tier Setup

Figure 3-2. 28 Camera, 3-Tier Setup


Tier 3: 8 Cameras
Tier 2: 8 Cameras
Tier 1: 12 Cameras

Ideal Capture Volume Sizes

Calculating the ideal volume size for a specific camera setup can have many factors involved and it can become a very hard question to answer. However, a good starting point would be to assume a two person, full body capture area in an ideal space (no restrictions on camera placement, etc.). For this we suggest the figures listed in Table 3-1.

Table 3-1. Ideal Volume Sizes for Specific Camera Setups (with standard lenses[a])

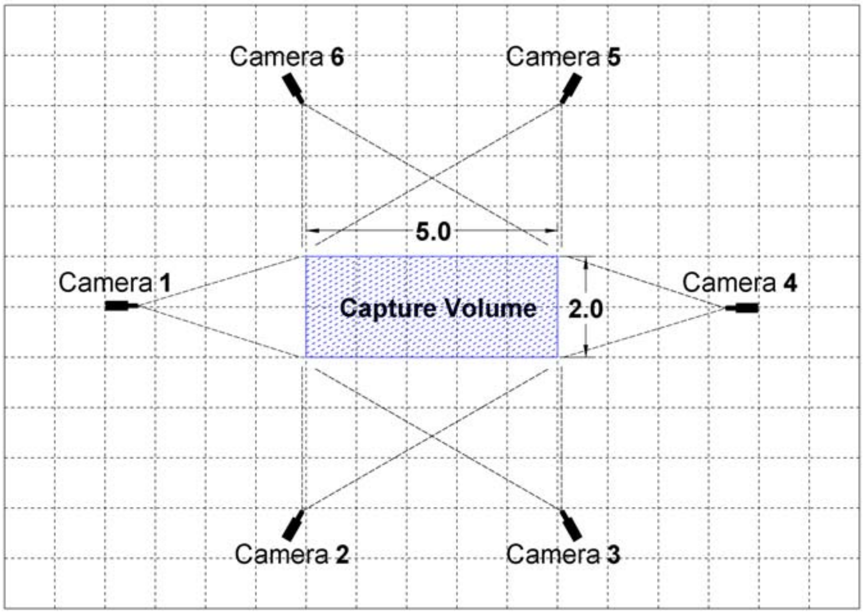
Number of Cameras	Dimensions (m)	Area (m^2)
6	5 x 2	10
10	7 x 5	35
14	9 x 6	54
16	13 x 6	78
32	13 x 11	143

---

[a] Standard lenses are 18-55 mm Zoom for Raptor-4, Raptor-E, Eagle-4 and Eagle cameras, and 6-15 mm Zoom for Raptor-H and Hawk cameras.

Why do 16 cameras give you 4 times the capture area of 8 cameras (you might ask)? Mostly because when using a small number of cameras you end up wasting a lot of the usable viewing cone of each camera. Using more cameras allows for more efficient usage of each individual camera.

Figure 3-3. Typical 6 Camera Setup


Camera 6
Camera 5
5.0
Camera 1
Capture Volume
2.0
Camera 4
Camera 2
Camera 3

Note: Capture volumes may vary depending on room size and the distance from the camera to the capture area.

Figure 3-4. Typical 8 Camera Setup

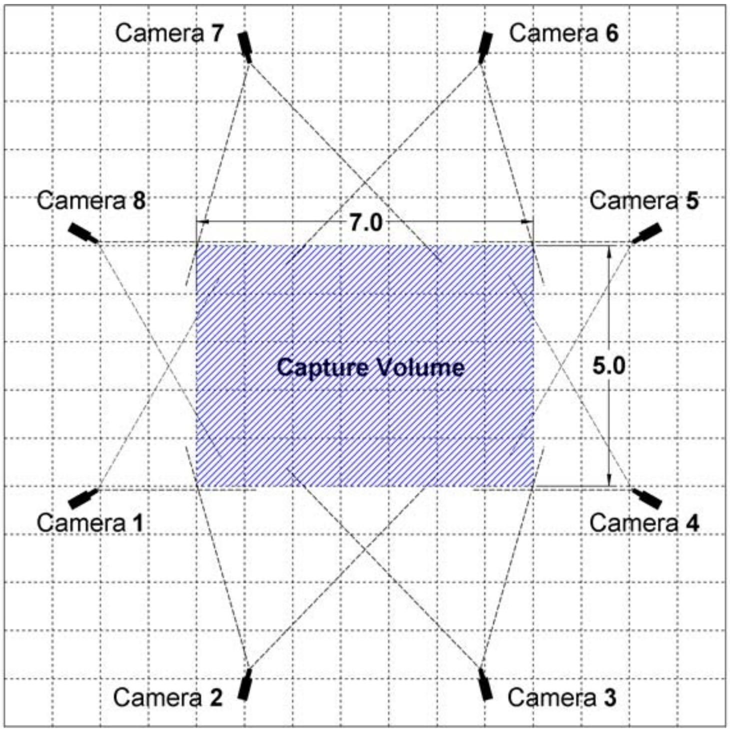

Camera 7
Camera 6
Camera 8
7.0
Camera 5
Capture Volume
5.0
Camera 1
Camera 4
Camera 2
Camera 3

Figure 3-5. Typical 10 Camera Setup

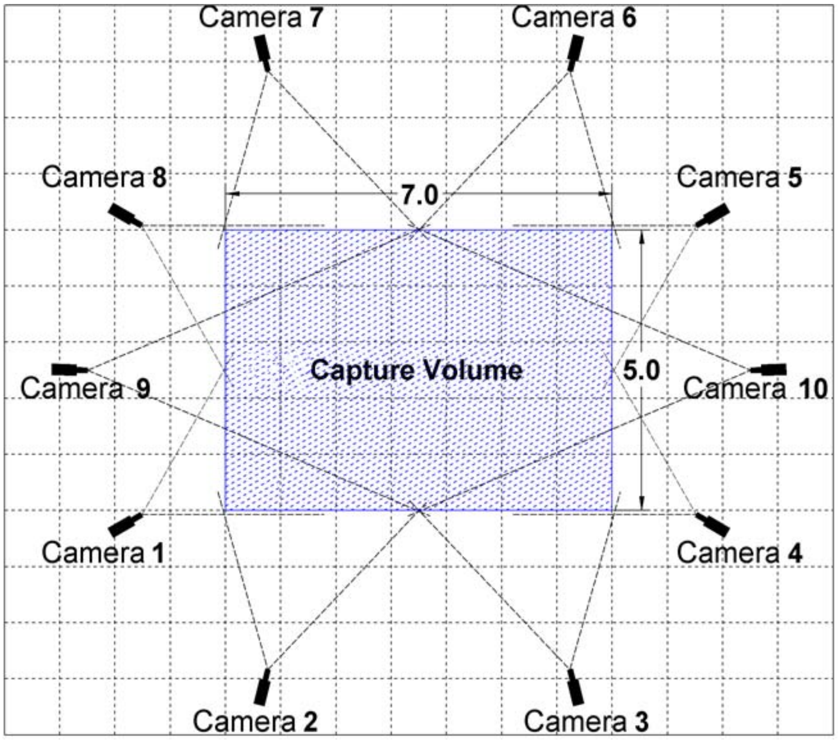

Camera 7
Camera 6
Camera 8
7.0
Camera 5
Capture Volume
5.0
Camera 9
Camera 10
Camera 1
Camera 4
Camera 2
Camera 3

Figure 3-6. Typical 12 Camera Setup

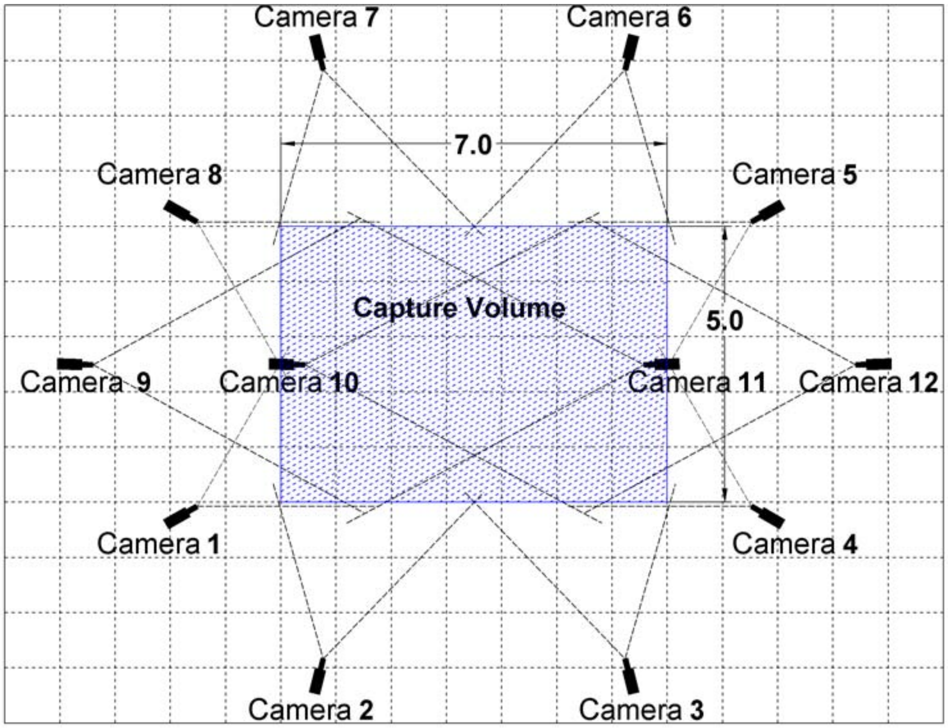

Camera 7
Camera 6
7.0
Camera 8
Camera 5
Capture Volume
5.0
Camera 9
Camera 10
Camera 11
Camera 12
Camera 1
Camera 4
Camera 2
Camera 3

Figure 3-7. Typical 14 Camera Setup

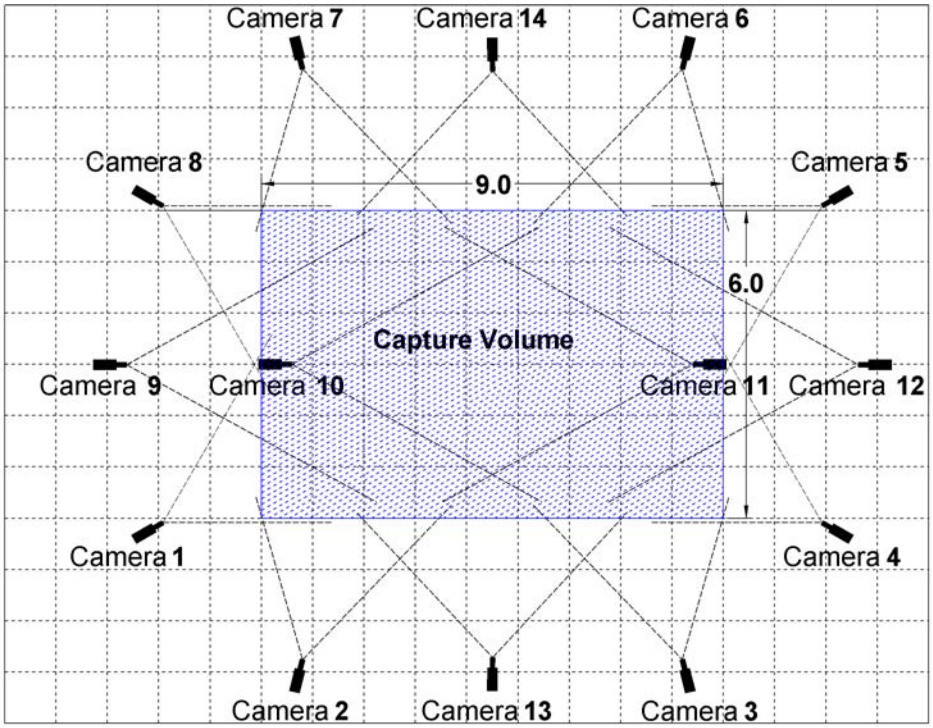

Camera 7
Camera 14
Camera 6
Camera 8
9.0
Camera 5
6.0
Capture Volume
Camera 9
Camera 10
Camera 11
Camera 12
Camera 1
Camera 4
Camera 2
Camera 13
Camera 3

Figure 3-8. Typical 16 Camera Setup

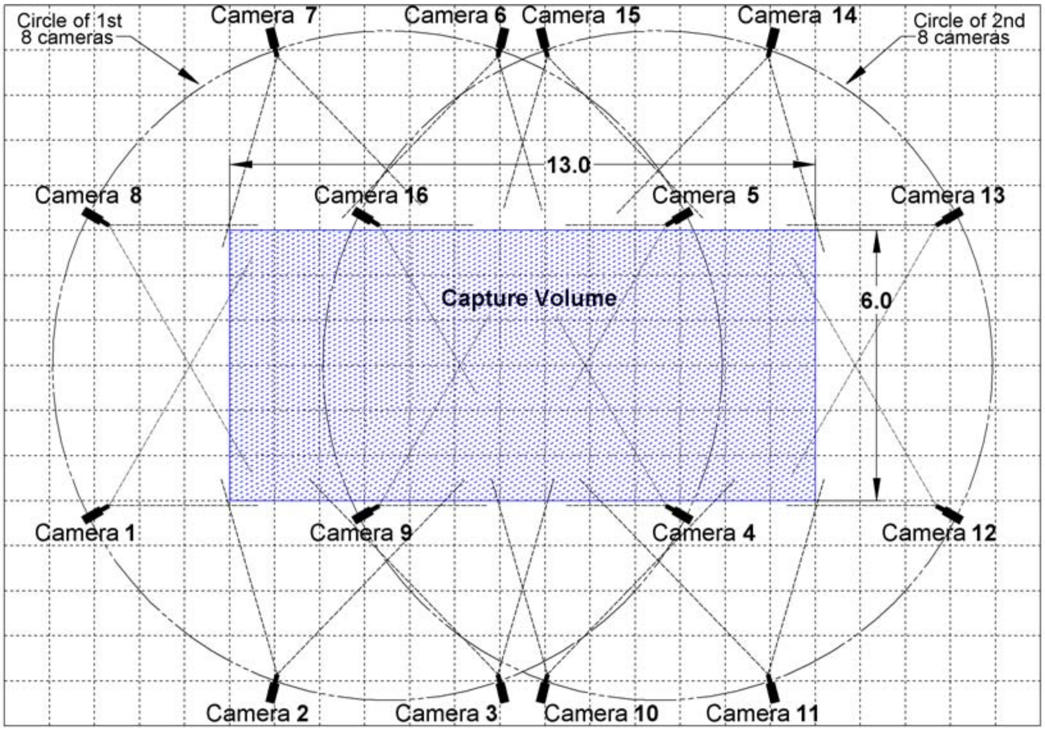
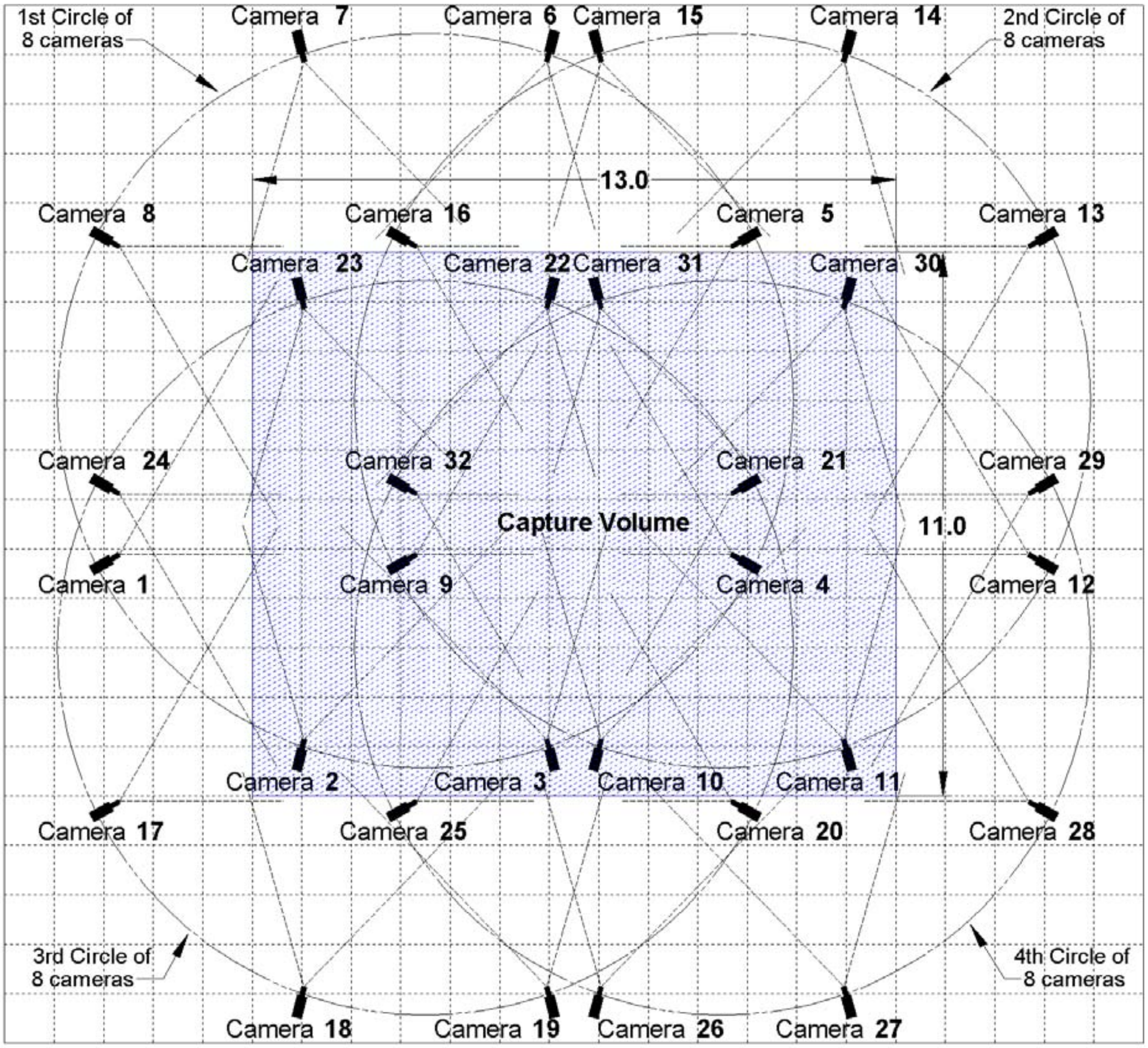

Circle of 1st 8 cameras
Camera 7
Camera 6
Camera 15
Camera 14
Circle of 2nd 8 cameras
13.0
Camera 8
Camera 16
Camera 5
Camera 13
Capture Volume
6.0
Camera 1
Camera 9
Camera 4
Camera 12
Camera 2
Camera 3
Camera 10
Camera 11

Figure 3-9. Typical 32 Camera Setup


1st Circle of 8 cameras
Camera 7
Camera 6
Camera 15
Camera 14
2nd Circle of 8 cameras
13.0
Camera 8
Camera 16
Camera 5
Camera 13
Camera 23
Camera 22
Camera 31
Camera 30
Camera 24
Camera 32
Camera 21
Camera 29
Capture Volume
11.0
Camera 1
Camera 9
Camera 4
Camera 12
Camera 2
Camera 3
Camera 10
Camera 11
Camera 17
Camera 25
Camera 20
Camera 28
3rd Circle of 8 cameras
4th Circle of 8 cameras
Camera 18
Camera 19
Camera 26
Camera 27

Note - The capture volume is divided into 4 overlapping regions, each containing 8 cameras. The regions are as follows:

Upper left quadrant	Cameras 1-8
Upper right quadrant	Cameras 9-16
Lower left quadrant	Cameras 17-24
Lower right quadrant	Cameras 25-32

Setting Up the Cameras

The key to placing cameras around the capture area is to position them where they will yield the highest resolution without excluding any part of the adjacent capture volume. In other words, if you plan to track 2 gait cycles, do not set up an area suitable for 4 gait cycles. When the tracking volume is increased, the quality and accuracy of the tracking data will decrease.

First, you will want to measure the room to establish the center of the tracking area.

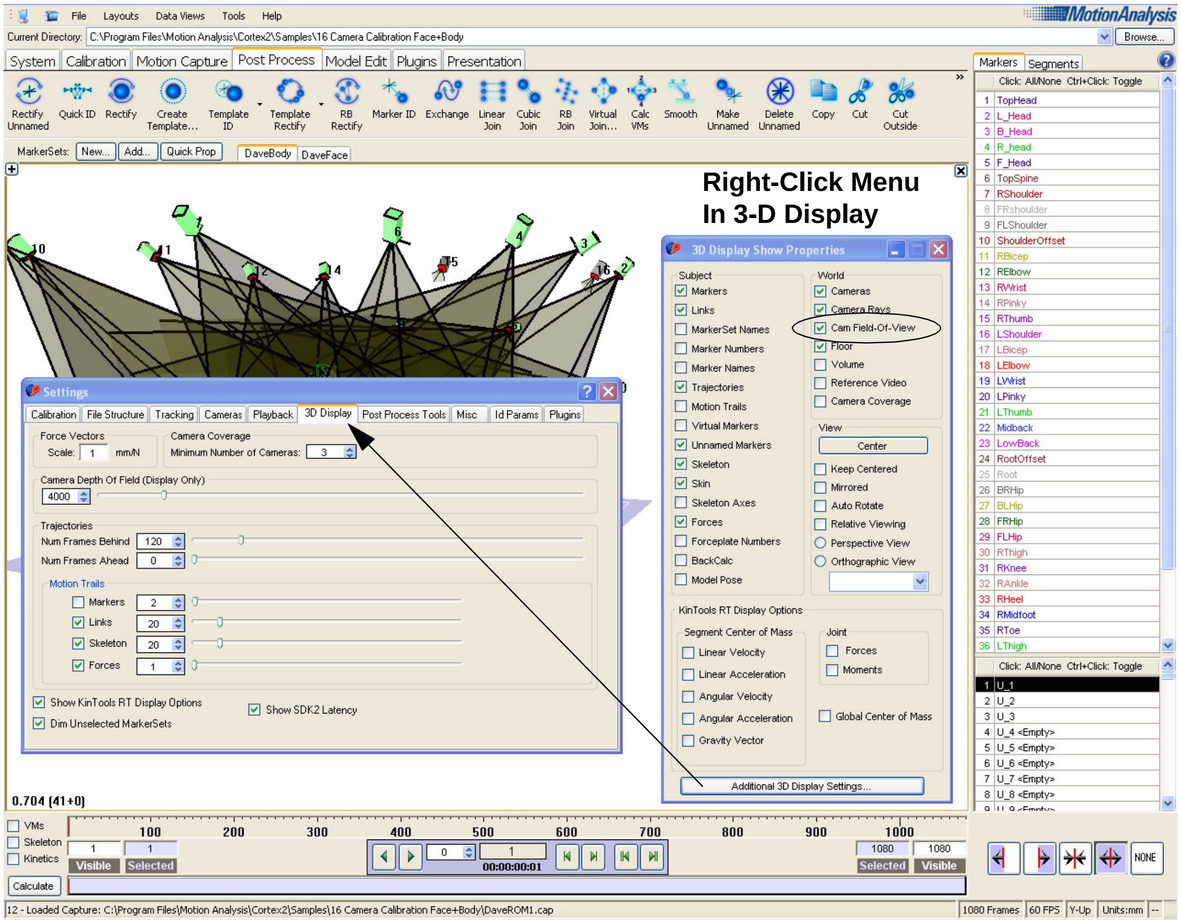
An Example 8 Camera Setup

For example, if you have a 10 x 15 meter room and you are using 8 cameras:

1. Measure in from the walls 5 and 7.5 meters. This should be the center of a 10 x 15 meter room.
2. Mark the center of the room or tracking area with a piece of masking tape.
3. Find the corners of the actual capture volume. For optimum tracking, the length and width of the capture volume should be no more than about half the room dimensions.
4. Position the cameras evenly around the capture area. Place the cameras above the top of the capture space, looking down, to prevent cameras from seeing an opposing camera’s ring light.
    - For most gait analysis installations, a height of 2 meters should be sufficient. For a larger capture area (e.g. full body or sports analysis), the cameras may need to be raised higher.
    - If a camera must view an opposing camera, use the mask function in **Cortex** to block the offending image.
    - Position the cameras so that they are equally spaced when viewed from the center of the capture area.
    - Beware of making the capture area too large. The resolution and the quality of the data may be compromised.
5. Place cameras in lower positions. Good results can come from adding cameras or positioning the cameras low (on the floor), looking up at the capture subject. This is also effective for capturing markers as the subject is stooped over or lying on the floor. Opposite camera ringlights can be masked out if necessary.

6. One by one, adjust each camera so it sees as much capture area as possible.
7. To see the camera view, right-click in the 3D view and then select **Show > Show Camera Field of View.** See Figure 3-10.

Figure 3-10. Show Camera Field of View


Right-Click Menu
In 3-D Display
3D Display Show Properties
Settings
Calibration
File Structure
Tracking
Cameras
Playback
3D Display
Post Process Tools
Misc
Id Params
Plugins
Additional 3D Display Settings...
Center

Subject:
- ☑ Markers
- ☑ Links
- ☐ MarkerSet Names
- ☐ Marker Numbers
- ☐ Marker Names
- ☑ Trajectories
- ☐ Motion Trails
- ☐ Virtual Markers
- ☑ Unnamed Markers
- ☑ Skeleton
- ☑ Skin
- ☐ Skeleton Axes
- ☑ Forces
- ☐ Forceplate Numbers
- ☐ BackCalc
- ☐ Model Pose

World:
- ☑ Cameras
- ☑ Camera Rays
- ☑ Cam Field-Of-View
- ☑ Floor
- ☐ Volume
- ☐ Reference Video
- ☐ Camera Coverage

View:
- ☐ Keep Centered
- ☐ Mirrored
- ☐ Auto Rotate
- ☐ Relative Viewing
- ○ Perspective View
- ○ Orthographic View

Settings > 3D Display: Force Vectors Scale: 1 mm/N; Camera Coverage Minimum Number of Cameras: 3; Camera Depth Of Field (Display Only): 4000; Trajectories Num Frames Behind: 120, Num Frames Ahead: 0; Motion Trails: ☐ Markers 2, ☑ Links 20, ☑ Skeleton 20, ☑ Forces 1; ☑ Show KinTools RT Display Options; ☑ Dim Unselected MarkerSets; ☑ Show SDK2 Latency

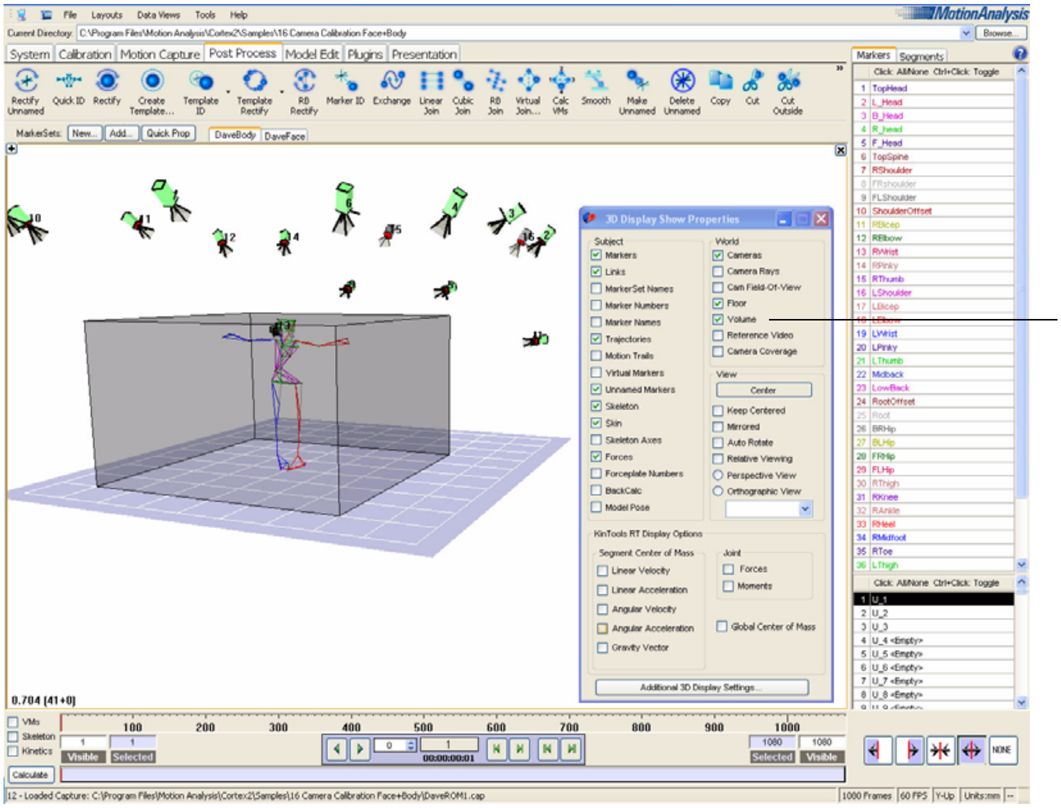
Current Directory: C:\Program Files\Motion Analysis\Cortex2\Samples\16 Camera Calibration Face+Body

12 - Loaded Capture: C:\Program Files\Motion Analysis\Cortex2\Samples\16 Camera Calibration Face+Body\DaveROM1.cap | 1080 Frames | 60 FPS | Y-Up | Units:mm

You can adjust the depth of the camera view by moving the slider in the Camera Depth of Field function in **Tools > Settings > 3D Display**. This does not change the depth of view the camera will have. It only provides a visual aid to determine if an object at a particular distance will be in the camera's field of view.

8. To see the capture volume, right-click in the 3D view, and then select the **Volume** check box from the 3D Display Show Properties window.

Figure 3-11. Show Volume


File
Layouts
Data Views
Tools
Help
MotionAnalysis
Browse...
System
Calibration
Motion Capture
Post Process
Model Edit
Plugins
Presentation
Rectify Unnamed
Quick ID
Rectify
Create Template...
Template ID
Template Rectify
RB Rectify
Marker ID
Exchange
Linear Join
Cubic Join
RB Join
Virtual Join...
Calc VMs
Smooth
Make Unnamed
Delete Unnamed
Copy
Cut
Cut Outside
MarkerSets:
New...
Add...
Quick Prop
DaveBody
DaveFace
Markers
Segments
Click: All/None Ctrl+Click: Toggle
0.704 (41+0)
VMs
Skeleton
Kinetics
Calculate
Visible
Selected
NONE
1080 Frames
60 FPS
Y-Up
Units:mm

Current Directory: C:\Program Files\Motion Analysis\Cortex2\Samples\16 Camera Calibration Face+Body

3D Display Show Properties

Subject
- ☑ Markers
- ☑ Links
- ☐ MarkerSet Names
- ☐ Marker Numbers
- ☐ Marker Names
- ☑ Trajectories
- ☐ Motion Trails
- ☐ Virtual Markers
- ☑ Unnamed Markers
- ☑ Skeleton
- ☑ Skin
- ☐ Skeleton Axes
- ☑ Forces
- ☐ Forceplate Numbers
- ☐ BackCalc
- ☐ Model Pose

World
- ☑ Cameras
- ☐ Camera Rays
- ☐ Cam Field-Of-View
- ☑ Floor
- ☑ Volume
- ☐ Reference Video
- ☐ Camera Coverage

View
- Center
- ☐ Keep Centered
- ☐ Mirrored
- ☐ Auto Rotate
- ☐ Relative Viewing
- ○ Perspective View
- ○ Orthographic View

KinTools RT Display Options

Segment Center of Mass
- ☐ Linear Velocity
- ☐ Linear Acceleration
- ☐ Angular Velocity
- ☐ Angular Acceleration
- ☐ Gravity Vector

Joint
- ☐ Forces
- ☐ Moments

☐ Global Center of Mass

Additional 3D Display Settings...

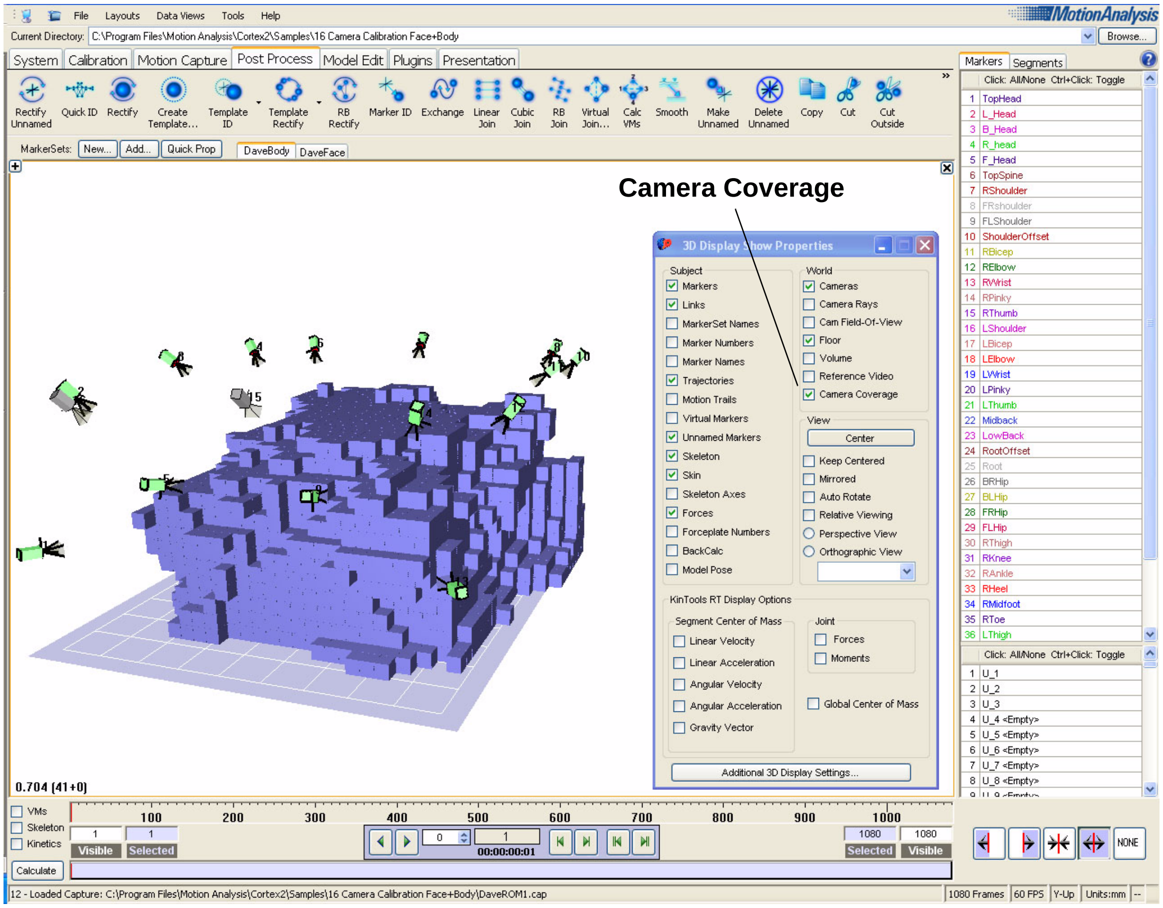
12 - Loaded Capture: C:\Program Files\Motion Analysis\Cortex2\Samples\16 Camera Calibration Face+Body\DaveROM1.cap

Volume

The Volume display is used as a visual aid when aiming the cameras in real time during setup. There is an option to delete all marker data outside of the volume in the **Plugins > X** panel.

9. To See the camera coverage in the volume, select the **Camera Coverage** check box in the **3D Display Show Properties** window. See Figure 3-12.

Figure 3-12. Show Camera Coverage



Current Directory: C:\Program Files\Motion Analysis\Cortex2\Samples\16 Camera Calibration Face+Body

3D Display Show Properties

Subject
☑ Markers
☑ Links
☐ MarkerSet Names
☐ Marker Numbers
☐ Marker Names
☑ Trajectories
☐ Motion Trails
☐ Virtual Markers
☑ Unnamed Markers
☑ Skeleton
☑ Skin
☐ Skeleton Axes
☑ Forces
☐ Forceplate Numbers
☐ BackCalc
☐ Model Pose

World
☑ Cameras
☐ Camera Rays
☐ Cam Field-Of-View
☑ Floor
☐ Volume
☐ Reference Video
☑ Camera Coverage

View
☐ Keep Centered
☐ Mirrored
☐ Auto Rotate
☐ Relative Viewing
○ Perspective View
○ Orthographic View

KinTools RT Display Options

Segment Center of Mass
☐ Linear Velocity
☐ Linear Acceleration
☐ Angular Velocity
☐ Angular Acceleration
☐ Gravity Vector

Joint
☐ Forces
☐ Moments

☐ Global Center of Mass

12 - Loaded Capture: C:\Program Files\Motion Analysis\Cortex2\Samples\16 Camera Calibration Face+Body\DaveROM1.cap | 1080 Frames | 60 FPS | Y-Up | Units:mm

10. Set the shutter speed in the **Cortex** software so the markers are bright and have a good threshold setting (usually about 500).
11. Place the calibration L-frame in the center of the taped area.

Note: The cameras need at least 20 minutes to warm up before collecting calibration or trial data.

Tracking With More Than 8 Cameras

As the subject moves from one region to the next in a multiple region capture volume, **Cortex** has no problem as the subject leaves the view of some cameras while entering the view of others. The only requirement is that at least two (preferably three or four) cameras can see the subject at all times.

For additional cameras to be effective, they must be sufficiently far apart so that the rays from a given marker to the two adjacent cameras subtend a large enough angle to yield good positioning data.

Using Many Cameras in a Small Volume

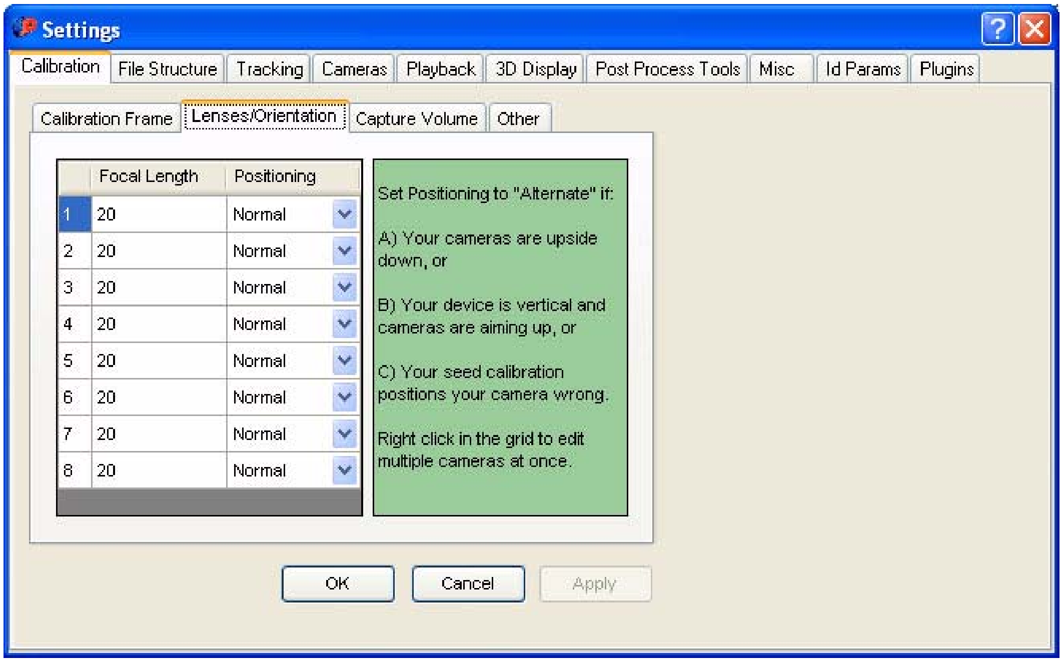
It is possible to use eight or more cameras effectively in a relatively small volume if there is sufficient height. We suggest placing half the cameras at a moderate height and the other half as high as possible. You may need to experiment to obtain the optimum camera adjustment for your lab or studio.

Adjusting Camera View for Increasing Height

If your capture volume is too high for your cameras, you may turn the cameras on their side (just as photographer may turn their camera on its side for increased height). Note that your camera width coverage will decrease. You may turn the cameras on their side, up to 89° without having to make any changes to the software settings. If you turn the camera 90° or greater, you will need to select the Alternate setting for the particular camera(s). This is done in the **Calibration > Calibrate** panel. Select **Details > Lenses/Orientation**, then change the setting from **Normal** to **Alternate**. These settings are also available by using the **Tools > Settings > Calibration > Lenses Orientation** tab. If the camera is hanging upside-down, you will need to use the Alternate position.

Note: It is recommended to not leave the cameras set too close to 90° (i.e. 85° to 95°) since it may appear Normal or Alternate and result in non-repeatable calibrations.

Figure 3-13. Lenses/Orientation Window


Settings
Calibration
File Structure
Tracking
Cameras
Playback
3D Display
Post Process Tools
Misc
Id Params
Plugins
Calibration Frame
Lenses/Orientation
Capture Volume
Other
OK
Cancel
Apply

	Focal Length	Positioning
1	20	Normal
2	20	Normal
3	20	Normal
4	20	Normal
5	20	Normal
6	20	Normal
7	20	Normal
8	20	Normal

Set Positioning to "Alternate" if:

A) Your cameras are upside down, or

B) Your device is vertical and cameras are aiming up, or

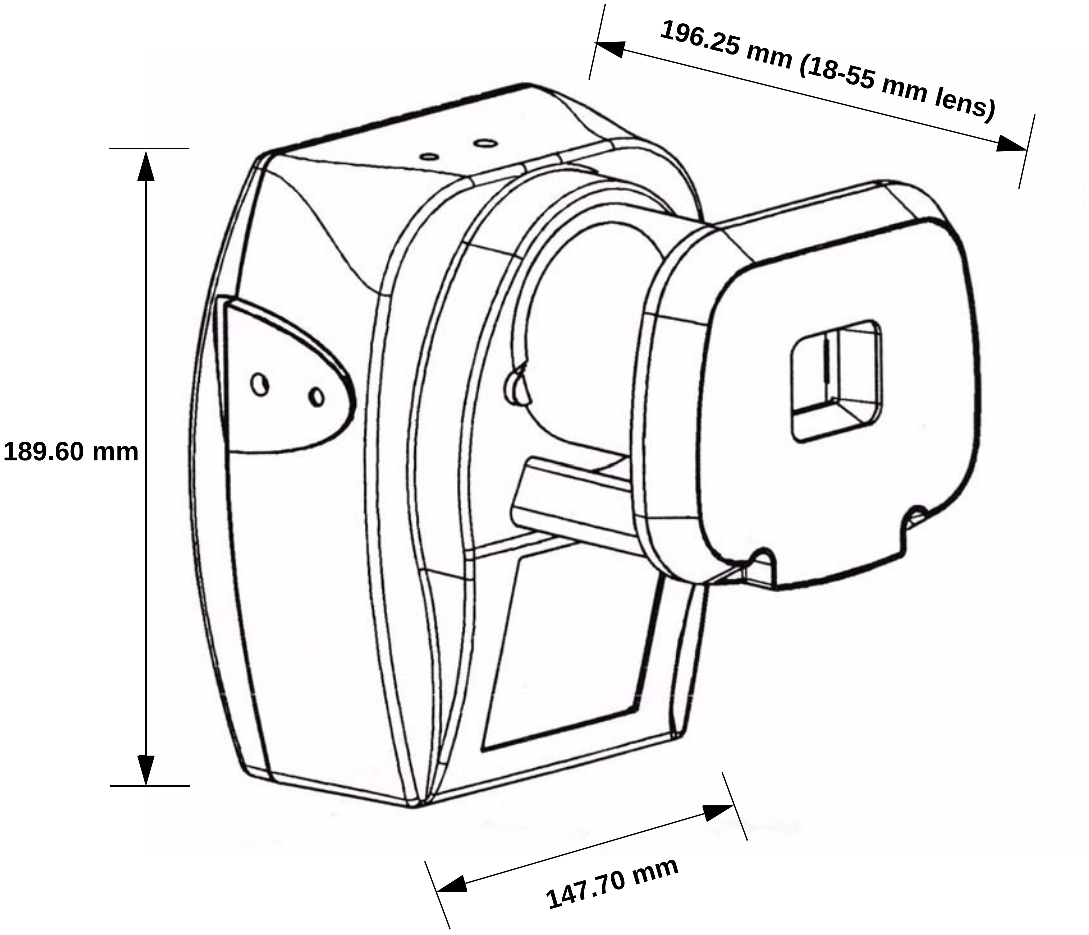
C) Your seed calibration positions your camera wrong.

Right click in the grid to edit multiple cameras at once.

Raptor-4, Raptor-E, Eagle-4 and Eagle Series Camera Physical Dimensions

The following diagram illustrates the physical size and weight of the Raptor-4, Raptor-E, Eagle-4, and Eagle digital cameras. The tripod mounting points are the holes used to hold the tripod bolt. There are four tripod mounting points on each camera.

Figure 3-14. Eagle Camera Physical Dimensions

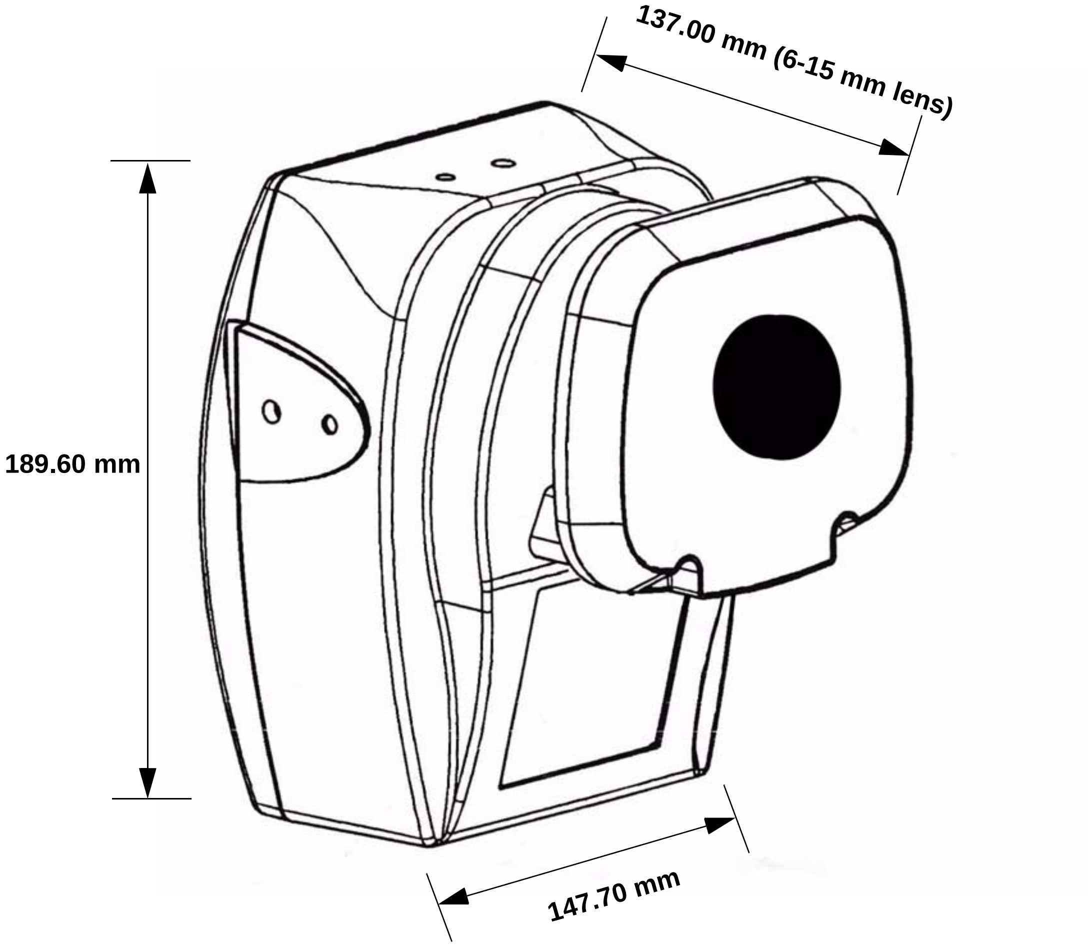


Tripod Mounting Points = 1/4 in. diameter x 20 threads/inch
Camera Weight = 2.22 kg with lens (4.90 lbs.)

Raptor-H and Hawk Camera Physical Dimensions

The following diagram illustrates the physical size and weight of the Raptor-H and Hawk digital camera. The tripod mounting points are the holes used to hold the tripod bolt. There are four tripod mounting points on each camera.

Figure 3-15. Hawk Camera Physical Dimensions



Tripod Mounting Points = 1/4 in. diameter x 20 threads/inch
Camera Weight = 2.13 kg with lens (4.70 lbs.)

Overview of the System Calibrating Process

System Calibration is performed in two stages: a seed and a wand calibration. A relationship must be established between real-world positions (object-coordinates) and the corresponding image-coordinates from the camera view. This is called calibrating the system. When a target is visible in two or more camera views, there is sufficient information available to track the targets in three-dimensional space.

The calibration of a given camera's view is completely dependent on the camera lens focal length and the position and orientation of the camera with respect to an arbitrary reference frame called the object-reference-frame. A change of any sort, which alters the relationship between the object-coordinates and image-coordinates, must be followed by a fresh calibration. This includes accidently bumping a camera tripod.

The calibration process calculates eleven calibration coefficients which implicitly define the configuration of a particular view. The calibration coefficients, together with the image-coordinates of a single target, are sufficient to define the path of an optical ray from the target to the camera through the object-space. If rays from two cameras intersect in space at a specific time, they define the 3D position of a target at that time. Therefore, the tracking process is one of intersecting optical rays generated from different views of the same event. **Cortex** employs a "best fit" tracking algorithm using only good camera views.

The Calibration Coordinate System

In order to calibrate the system, you must first decide on the location of the origin and orientation of your object-reference-frame. This is determined by the calibration L-frame. All results generated by the tracking process are referred back to this reference frame.

The selection of an object-reference-frame is arbitrary. However, judicious selection is advised. In most cases, it is advisable to align one axis of the frame with the axis of gravity and another with the predominant direction of motion. Remember, that all targets will be tracked with respect to the object-reference-frame, and that the units used to locate the control points (mm, cm, inches, etc.) will be the same units used in the tracking process.

For computer animation users, a commonly used coordinate system convention is called "Y-up", with the Y axis pointing up, the +Z axis normal to the direction of motion and the +X axis oriented from the person's right side to left side. Looking at the frontal view, you would see a normal X-Y plot (Y-up, X-right) and the +Z coordinate sticks out of the screen.

For biomechanics applications, it is common to use a coordinate system with +Z up, +X in the direction of forward motion, and +Y toward the subject's left side.

The coordinate convention you use is your choice. Be sure that:

- The coordinates of the calibration L-frame are entered into your project file(s) correctly.

- The calibration L-frame is oriented correctly in the room when you collect the calibration trial. The position of the calibration L-frame determines the orientation of your calibration.

Note: The International Society of Biomechanics (ISB) has officially adopted the convention that the Y axis should point up. This has the advantage that in both 2D and 3D studies, the Y axis is up. However, many studies and software packages use the Z-up coordinate system favored by mathematicians.

Control Points

Once a reference frame has been selected, you must provide a number of calibration markers with known locations, which can be used for control purposes; hence, these calibration markers are known as control points. The control points serve much the same purpose as the simple scale widely used for two-dimensional studies—they are, in fact, a three-dimensional yardstick representing the X, Y, and Z dimensions.

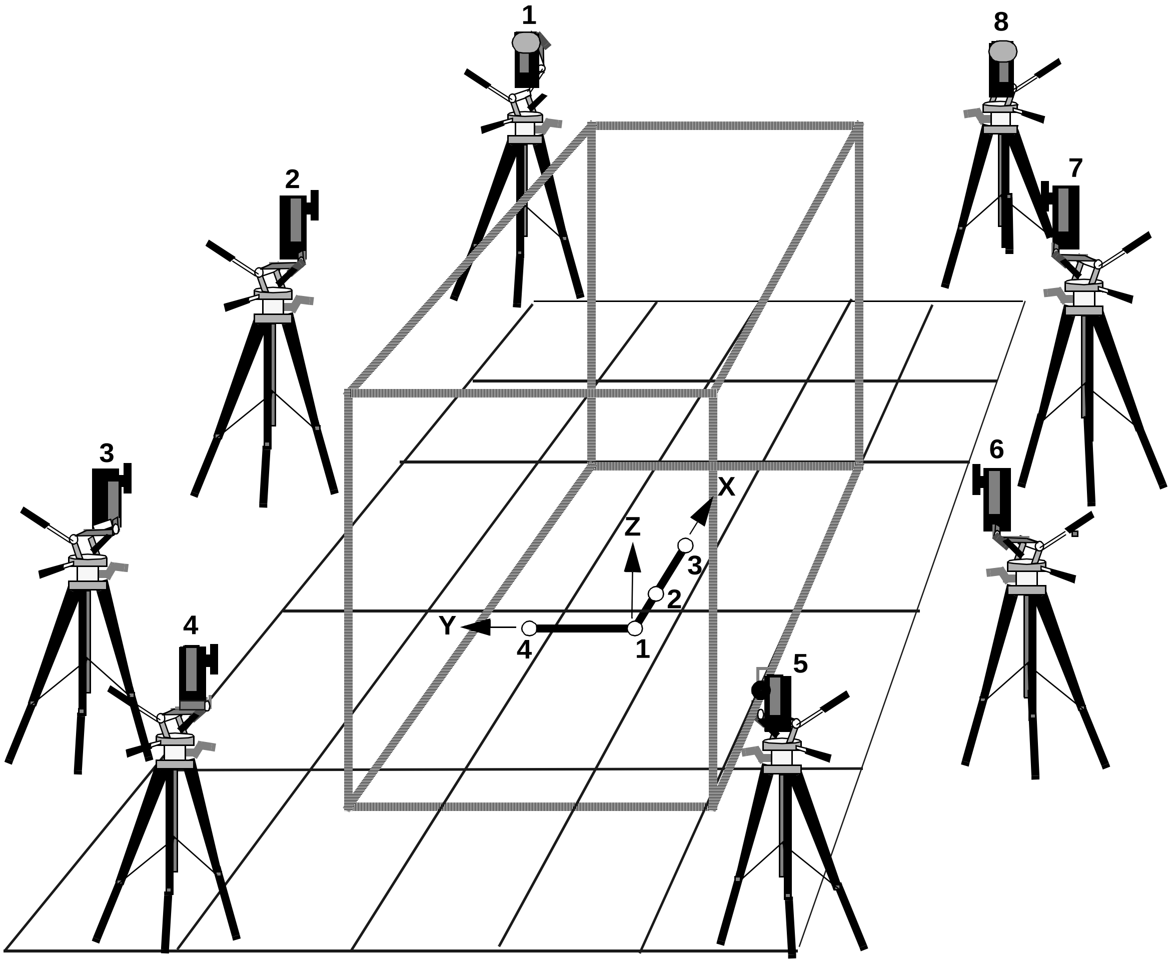
Motion Analysis offers a calibration L-frame with four retro-reflective spheres. The relative position of the spheres have been accurately measured and they define the origin and direction of the Global Coordinate System used in the motion measurements. See Chapter 6, Calibration Tab for more details.

Placing the Calibration L-Frame

Mark the floor area with tape where the motion is to take place.

- Set Marker #1 of the calibration L-frame at the desired origin of the capture volume.
- If the orientation of the coordinate system is not important, the square should be rotated so as many control points as possible can be seen by all cameras.
- The calibration L-frame should be seen by at least half of the cameras to give a good calibration. The other half of the cameras can be calibrated using the wand, with an Extend Seed menu item. You may need to adjust the cameras at this point.

Figure 3-16. Placing the Calibration L-Frame In the Capture Volume (Z-Up)


1
8
2
7
3
6
X
Z
3
2
Y
4
1
4
5

Marker Sizes and Maximum Distances for Motion Analysis Cameras

The limiting factor in what size marker works in what volume is the distance the marker is viewable (and usable) from the camera.

"Min 3 lines" below is the minimum number of scan lines (or pixels) to allow in calculating a 2D centroid. As a rule, the more lines, the cleaner the 2D data and resulting 3D data. But once you get above 3 lines, the data is very clean and going more lines per centroid does not generally make the data any better. This setting is found in the **Tools > Settings > Cameras** tab.

Table 3-2. Marker Size and Maximum Distance for Raptor-4, Raptor-E, Eagle-4 and Eagle Cameras

Raptor-4, Raptor-E, Eagle-4 and Eagle Camera Marker Size	Distance (m)	
	Min 3 Lines	Min 2 Lines
6 mm (1/4 in.)	4.2 m	7.0 m
12 mm (1/2 in.)	8.0 m	12.0 m
19 mm (3/4 in.)	10.7 m	15.0 m
25 mm (1 in.)	12.1 m	16.0 m

These are empirical tests taken from an Eagle camera with the 18-55 mm zoom lens, at a capture rate of 60 Hz, 100% brightness, and a threshold = 500.

Note: Hawk cameras will require markers that are approximately 50 to 100% larger than those listed in Table 3-2.

When using 1/2-inch markers, the useful distance for VERY CLEAN data (Min. 3 lines per centroid) is about 8 meters. Going to a minimum of 2 lines per centroid, takes the usable distance to 12 meters. Going to the 3/4 inch marker gains another 3 meters (to 15 meters). A note of interest is that going to a one-inch marker does not give a big boost in distance. Other factors come into play, such as the inverse square law about light falling off as we get further from the source. Above 16 meters, the markers are "self extinguishing".

Our experience indicates that if you go beyond about 10 meters in any direction of the capture volume (length or width), it is best to have a second tier of cameras in the middle of the longer dimension. This is a big benefit for multiple person captures as it minimizes editing time needed since you get lots of good solid 3D marker points.

Troubleshooting Camera Problems

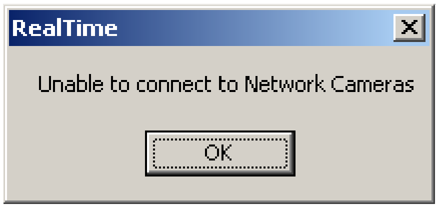
If Any Cameras Fail to Respond

Motion Analysis sets the default network address in the software to 10.1.1.199. Please note, some computers have multiple network cards installed in them. Please make sure they are labeled so there is no confusion.

If you or your IT department has changed the network address for your system or your cameras, please make note of this for reference as it will save you time in the future.

If you see the error shown in Figure 3-17, there can be multiple reasons why.

Figure 3-17. Unable to Connect to Cameras Error

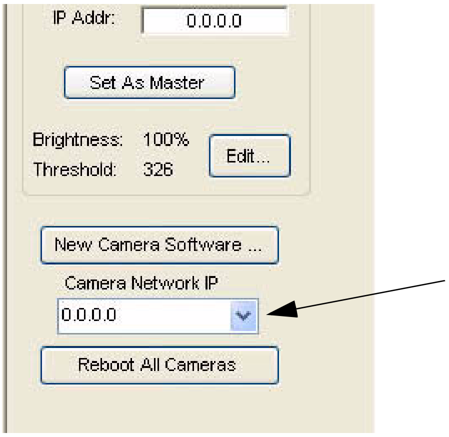


Unable to connect to Network Cameras

The following are some steps to try and fix the problem, starting with the simplest and progressing to the more complex.

1. Under the **System > Cameras** subpanel, verify the Camera Network Address in the Camera Network Address box.

Figure 3-18. Network Address Box



IP Addr: 0.0.0.0

Brightness: 100%
Threshold: 326

Camera Network IP: 0.0.0.0

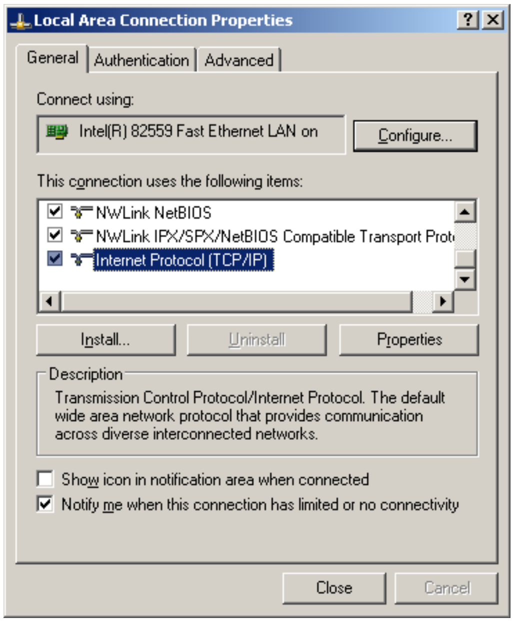
If nothing has been changed this should have a network address of 10.1.1.199. Try and connect to cameras again. If this does not fix the issue please move on to the next step.

2. Make sure that the Network cable going from the back of the computer to the EagleHub is securely installed. Motion Analysis uses the on-board network port for the camera network. If you purchased a computer from another source, this may not be how your system is setup. Please take note of this when checking the connections, as it will be useful when talking to Motion Analysis Customer Support staff.
   - a. Unplug the network cable from the back of the computer and plug it back in.
   - b. Do the same for the connectors on the EagleHub. You should hear an audible “Click” when inserting it back into the jack.
3. If Windows Updates has been recently run (they may be running in the background), there may be a possibility that the Microsoft Windows Firewall was either installed or turned on. This will need to be turned off, as well as any other Firewall software installed on your motion capture computer. Because of the nature of the digital cameras, it is required that the network coming in to the computer, on a particular IP address, is open for streaming data. If your facility requires a Firewall to be installed for their network, it will need to be configured to leave the camera network untouched and open.

   You can turn off the Windows Firewall by going to the **Start > Settings** menu in your Windows desktop and then selecting **Control Panel > Security Center**. This is a feature in Windows XP, Service Pack 2 and later software.

4. Double-check to make sure the Network Address that is set in **Cortex** is the same as the Network Address that is assigned to your Network Interface Card (NIC). To do this follows these steps:
    - **a.** From your desktop, select **Start > Settings > Control Panel > Network Connections**. You should have a Local Area Connection. There may also be "1394 IEEE Connection", this is for Fire Wire and can be ignored.
    - **b.** Right-click the appropriate network connection for the Motion Analysis Network and select **Properties** from the drop down menu.
    - **c.** Under the General tab, scroll down and select **Internet Protocol (TCP/IP)** and click on the **Properties** button.

Figure 3-19. Internet Protocol (TCP/IP) Properties Selection



Connect using:
Intel(R) 82559 Fast Ethernet LAN on

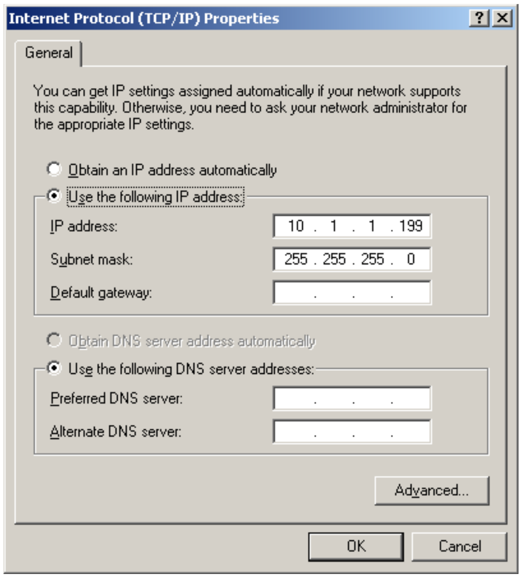
This connection uses the following items:
☑ NWLink NetBIOS
☑ NWLink IPX/SPX/NetBIOS Compatible Transport Prot
☑ Internet Protocol (TCP/IP)

Description
Transmission Control Protocol/Internet Protocol. The default wide area network protocol that provides communication across diverse interconnected networks.

☐ Show icon in notification area when connected
☑ Notify me when this connection has limited or no connectivity

  d. You should have “Use the following IP address” selected. If not, please make sure you have selected the proper network connection. You may close this window and return to Step 4b. The IP Address should be 10.1.1.199 and the Subnet Mask should be 255.255.255.0. If either of these is incorrect, please change them.

Figure 3-20. IP Address and Subnet Mask Address



You can get IP settings assigned automatically if your network supports this capability. Otherwise, you need to ask your network administrator for the appropriate IP settings.

○ Obtain an IP address automatically

● Use the following IP address:

IP address: 10 . 1 . 1 . 199

Subnet mask: 255 . 255 . 255 . 0

Default gateway: . . .

○ Obtain DNS server address automatically

● Use the following DNS server addresses:

Preferred DNS server: . . .

Alternate DNS server: . . .

5. If the software has still not connected to the Camera Network, use the CMD Line interface in Windows to Ping the cameras to verify if there isn’t a hardware failure.

  a. To Ping a camera, select **Start > Run** from the Windows desktop. In the pop up window, type in **`cmd`**. This will launch the command prompt.

  b. Type in `Ping  10.1.1.201` and press **Enter**. If the request times out (it will try 4 times) try doing the next number, 10.1.1.202 and so on. Your cameras should be set to 10.1.1.201 for camera number 1 and 10.1.1.202 for camera number 2 and so on (unless changed by you or your IT personnel). If the cameras do not respond then you may need to use your Eagle Test Cable to determine the Camera Network address. The Eagle Test cable is the black cable about 1 meter in length, one end plugs into the Aux port on the back of the camera, the other end has a VGA port, a COM port and a BNC connector.

The Ping command should return a message similar (but not exactly the same) as follows:

```
Pinging 10.1.1.201 with 32 bytes of data:

Reply from 10.1.1.201: bytes=32 time=20ms TTL=128
Reply from 10.1.1.201: bytes=32 time=20ms TTL=128
Reply from 10.1.1.201: bytes=32 time=20ms TTL=128
Reply from 10.1.1.201: bytes=32 time=20ms TTL=128

Ping Statistics for 10.1.1.201:
          Packets: Sent=4, Received: 4, Lost=0 (0% loss),
Approximate Round trip times in milliseconds:
         Minimum=0ms, Maximum=242ms, Average= 128ms
```

If you are getting a message that says:

```
Pinging 10.1.1.201 with 32 bytes of data:

Request timed out.
Request timed out.
Request timed out.
Request timed out.

Ping Statistics for 10.1.1.201:
          Packets: Sent=4, Received: 0, Lost=4 (100%
loss),
Approximate Round trip times in milliseconds:
         Minimum=0ms, Maximum=0ms, Average= 0ms
```

Then the camera is not responding to Ping requests.

6. This last step involves trying to determine if there is a camera, cable, or connection that may be causing the system to not identify the cameras. The best way to do this is to unplug all of the cameras from the EagleHub and then individually plug each camera in (do not connect any other camera cables to the hub). It does not matter which RJ45 port you connect the Ethernet switch. The same applies to the power connector. The only other connection going into the EagleHub is the cable coming from the back of the Host computer (**Cortex** tracking computer).

   After you have plugged-in a camera, click-on the **Connect to Cameras** button on the Real-Time Dashboard. If this works, unplug this camera and set it off to the side or label it as good. Move on to the next camera doing the same, and so on, each time remembering that there should only be one camera plugged into the EagleHub at a time. This will help you narrow down if there is a conflict.

   After running through each individual camera, it is very useful to power down the EagleHub to help clear out any stored data that may be in its memory. You may also want to take the time to write down IP address for each camera. If you run into a problem with multiple IP

Addresses being the same, this could be the problem. Each camera needs to have it's own independent IP Address. No two addresses can be the same. This makes each camera unique and will help the system identify them.

Socket Error

When connecting to the cameras on the RealTime Dashboard, if you encounter a SOCKET ERROR, you will need to verify the following:

- that the Ethernet connector on the back of the Host Computer is working properly.
- that the Ethernet cable running from the EagleHub (or switch connected to multiple EagleHubs) to the Cortex Host Computer is connected.

Function Not Found In Library Error

If you get the message **`ERROR: Function not found in library`**, you have an older version of a library that is not working or is needed. If you do not have the A-D option, check the **C:\Winnt\System32** directory and rename the file **nidaq32.dll** to be **nidaq32.dll.old**. Then close and relaunch **Cortex.** This applies for Windows operating systems. If you are using a different operating system, you will need to do a search for the file **nidaq32.dll**.

Relationship Between Capture Volume and Marker Size

Listed in Figure 3-3 are Optimal (Highest Accuracy), Large Volume, and Extended Volume capture areas for the 6, 8, and 10 camera systems. Larger volumes require more cameras. Different shaped capture areas are also possible.

At the extremes, volumes will vary with ceiling heights and can vary with optical conditions including external lighting.

Table 3-3. Guidelines for Selecting Marker Size

		Normal Capture Volume	
	Marker Size	**meters**	**# Cameras**
Highest Accuracy	Raptor/Eagle = 3/8-inch (9mm)	2.5 x 2.5	6
	Hawk = 1/2-inch (12.5mm)	2.5 x 3.5	8
Large Volume	Raptor/Eagle = 1/2-inch (12.5mm)	3.5 x 3.5	6
	Hawk = 3/4-inch (19mm)	3.5 x 6	8
Extended Volume	Raptor/Eagle = 3/4-inch (9mm)	5 x 5	6
	Hawk = 1-inch (12.5mm)	5 x 8	8
1/8" and 1/4" markers are also available for smaller volumes such as face, hand, or foot capture volumes.			

Insight Focusing for Raptor Series Cameras

Setting Up the Cameras for Insight Focusing

1. Place the Insight Focusing Marker into the volume. This marker should be at least 8 pixels high, and have a centroid calculated for it.
2. Select **Run** in the Real Time dashboard.
3. Enable greyscale centroid calculations for the cameras in **Settings > Tools > Cameras.**
4. **Shift + Left Mouse** click on the marker in the 2D display of a camera.
    - This will set the greyscale region about the clicked marker.
    - Ensure that only this marker is visible within the greyscale region.
    - If other markers are visible, move them in the volume, or change the greyscale region to not include them.
    - The marker should be at least 8 pixels high, and have a centroid calculated for it.
5. Do these steps for each camera you will be focusing.

Selecting a Camera To Focus

1. Opening this dialog put the cameras into "Insight" mode.
    - When in this mode, the camera to be focused will have a pair of spectacles in its LED display. The other cameras will have a target symbol.
2. While in the volume, use the "Right" and "Left" buttons to switch between which camera will be focused.
    - This is reflected by a pair of spectacles on the LED display board.
    - You can use the "Top" button on the wireless control to toggle the cameras in and out of Insight mode.
    - Closing this popup will take the cameras out of Insight mode.
3. Use the "Bottom" button on the wireless remote to start focusing the selected camera.
    - If the marker becomes obscured, the camera will stop providing focus feedback and go back to the mode where the spectacles are shown.
4. This will display a graphic to assist with focusing the camera
5. Once focusing of this camera is done, use the "Right" and "Left" buttons to select another camera to focus.

Focusing a Camera

1. Initially an arrow pointing down will be shown in the LED display.
2. Begin turning the focus dial on the camera.
3. When the arrow points up, stop and begin turning the dial in the opposite direction.
4. Next a stop sign with an arrow in it will be displayed. Stop turning and again slowly turn in the original direction.
5. As you turn, a red box outline will appear. Continue to turn slowly, and the box will fill in as the focus gets better.
6. When the red box is filled in, it will next turn into a green box outline. Continue turning slowly until the green box is filled it.
7. When the green box is completely filled in, an optimal focus has been reached.

Wireless Remote Functionality While In Insight Mode

Top Button = Toggle "insight" focusing

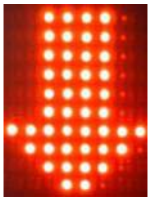
Bottom Button = Start focusing the camera

Left Button = Go to prev camera (by camera number)

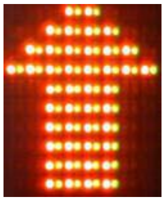
Right button = Go to next camera (by camera number)

Camera Status Indicators

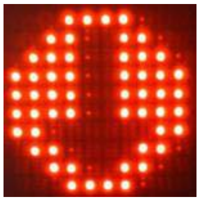
Figure 3-21. Insight Focusing Camera Status Indicators



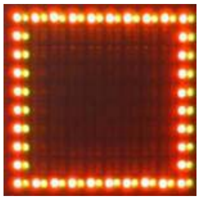
1. Begin the focus procedure, turning the lens focus ring any direction.



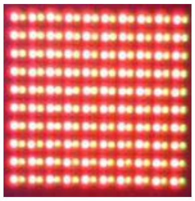
2. Turn the lens focus ring in the opposite direction.



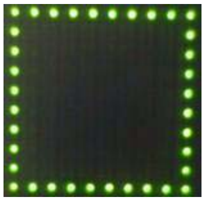
3. Turn the lens focus ring in the opposite direction again (should be the same direction as step 1).



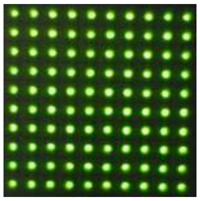
4. Focusing in progress (about 50%).



5. Focusing progress continues (about 75%).



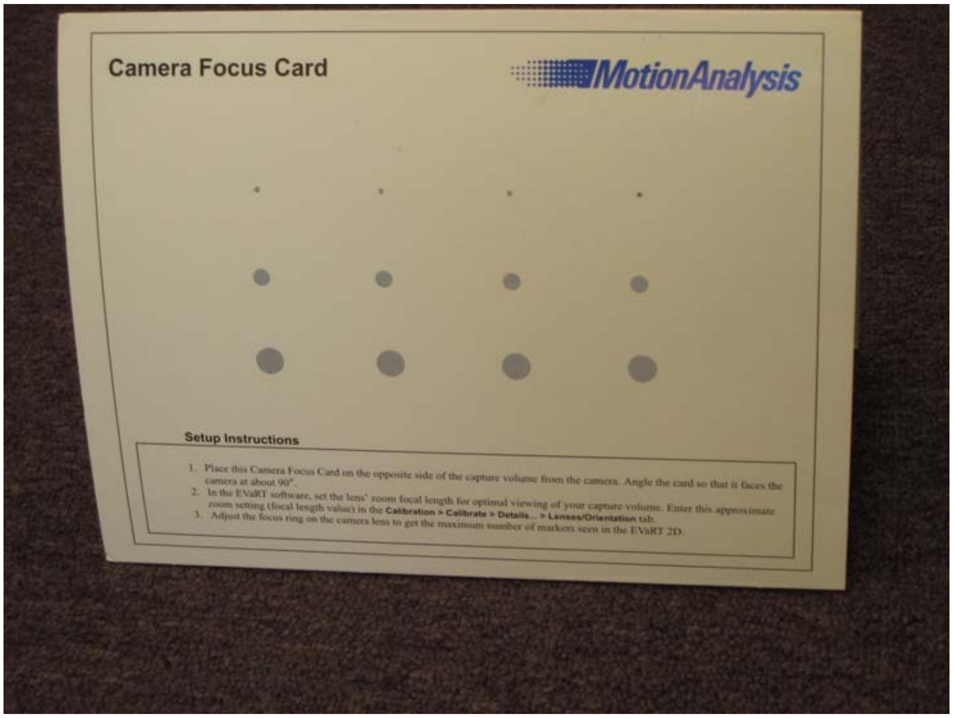
6. Focusing progress continues (about 90%)



7. Focusing complete (100%)

Focusing with the Camera Focus Card

Figure 3-22. Camera Focus Card



Setup Instructions

1. Place this Camera Focus Card on the opposite side of the capture volume from the camera. Angle the card so that it faces the camera at about 90°.
2. In the EVaRT software, set the lens' zoom focal length for optimal viewing of your capture volume. Enter this approximate zoom setting (focal length value) in the **Calibration > Calibrate > Details... > Lenses/Orientation** tab.
3. Adjust the focus ring on the camera lens to get the maximum number of markers seen in the EVaRT 2D.

A Camera Focus Card ships with newer systems. If you do not have one, contact support@motionanalysis.com or you can make one that works for you with cardboard and some retro-reflective tape. The Camera Focus Card is a simple piece of card that unfolds into an A shape. On the front surface are 3 rows of 4 flat disc markers of 3 different sizes with instructions for use. In brief:

1. Place the card in the middle of the volume so that the face is roughly square-on with the camera.
2. Choose a 2D view of that camera and connect and run.
3. Adjust the brightness and threshold.

   For a typical full-body volume in a room with little extraneous sunlight or incandescent lamps, brightness at 100 (full) and threshold at 400-500 are usually good starting points.

4. Adjust the focus until as many as possible of the 12 discs are clearly seen in the 2D view.

Until the cameras have been calibrated at least once for a given lens setting the show centroids should be ignored. Later versions of the software allow zooming in and out of the 2D view. Filling all the PC screen with the focus card view will make fine-tuning the focus of the camera easier.

It is highly recommended that an assistant is used for this procedure. One person adjusts the lens following the instructions of the person viewing the computer’s monitor. Because the focus can be very sensitive, the smallest movement of the focus ring can cause a large effect. It can also be confusing as the focus is moved through the ideal setting. Just out of focus one side looks much like just out in the other direction. When you are close to the ideal focused place on the lens, just touching the lens can seem to be enough to move the focus ring.

If the cameras have been mishandled it is possible the focus will be so far out that nothing will be seen. A good starting point is zoom out (minimum focal length) and focus set to infinity often marked with the ∞ symbol. Also some lenses have one ∞ focus for zoomed in and another for zoomed out. This is sometimes marked **t** for telephoto (zoom in) and **w** wide angle (zoom out).

In a typical full body volume the cameras should be able to be focussed such that all 12 of the discs on the focus card can be seen. This is almost always possible with cameras with one million or more pixels—but the top line of small discs may not be seen in large volumes. Also in volumes with poor ambient conditions, where the threshold need to be set high, the top line may not be fully resolved. This will be more marked with cameras with less than one million pixels (Hawk and Raptor-H cameras). In these cases try to judge if the large and mid size discs look acceptable.

If the focus card has been mislaid or damaged then use a selection of markers of various sizes stuck on a matt surface. Place the markers several centimeters apart so that their images do not “stream” or merge when the ring-light is bright.

Lens Aperture

Most lenses have an aperture, which can be made smaller to let in less light and opened to let in more light. This is often referred to as the F-stop. The F-stop number is a ratio of the focal length of the lens to the diameter of the aperture. A lens is said to be "wide open" when it is set on its smallest F-stop, or with the aperture opened as wide as possible.

It is very unusual to have to change the F-stop on a Motion Analysis camera. Often it will be locked at its optimum value. On most larger SLR style lenses, it takes a very deliberate action to change the aperture However with c-mount zoom lenses, often supplied on Hawk cameras (almost always 6-15mm) it is not lockable and very easy to change (accidentally) when adjusting other lens parameters. If this happens, follow the focus card procedure and change the aperture form one extreme to the other. When fully open, the camera should be able to see most of the markers. If there are extra reflections in the view, close the aperture until they disappear. Note that a fully closed aperture with bad focus will look similar in the 2D view. Trial and error is needed to find suitable lens adjustments.

Ringlight Brightness in Cortex

For Hawks, Eagles and all Raptor cameras, this is a software setting. It simply controls the amount of light coming from the ring light. It is usual to start with this at 100 (max). Lower the value for small markers or to help combat reflections. If the aperture is made smaller, the brightness would need to be raised in order for a sensor to receive the same amount of light in any given situation.

Threshold Setting in Cortex

This sets the value for the pixels on a camera above which data is passed for the software to make circle fitting calculations. It is usual to start with this at 500 (half). Raise this value if there is a lot of stray light or reflections. Lower the value to see smaller markers or markers at the far side of the volume.

Frame Rate in Cortex

The number of frames per second or Hz. Set for all MAC cameras in the system. Note there are different maximums for each camera type. Also above certain speeds each camera type will start to operate in partial scan mode.

Shutter (and Strobe) setting in Cortex

Note there are different shutter types for each camera type. The default is 1000 (th of a second). In most circumstances, it is unlikely that this will need to be changed.

Vignetting

If a very small from-factor lens is used with a very large sensor/film, less light would get to the corners of the image than the middle. This makes the corners and edges appear faded. Motion Analysis cameras have been optimized so there is no significant vignetting. However closing an aperture means that only the middle part of the lens is being used so if an aperture is closed too much, then this effect will begin to be noticeable.

Depth of Field

Depth of field is the distance between the nearest and furthest parts of a scene that can be imaged with acceptable sharpness. In motion capture, we need to have the near and far ends of the capture volume in good focus. This is not the same as range. Depth of field is affected by many aspect of lens design and these parameters have been optimized at the design and manufacturing stage for Motion Analysis cameras. It will also be affected by the F-stop of the lens. A small aperture increases depth of field but if you close it too much you will affect range and cause vignetting. It is recommended to leave the aperture at the factory setting.

Range

This is the furthest distance that a marker can be adequately tracked to be useful for motion capture. It is not possible to give a specific value for a given camera type as it depends on many variables, such as ambient conditions, threshold, brightness, aperture, marker size etc.

Chapter 4 The Cortex User Interface

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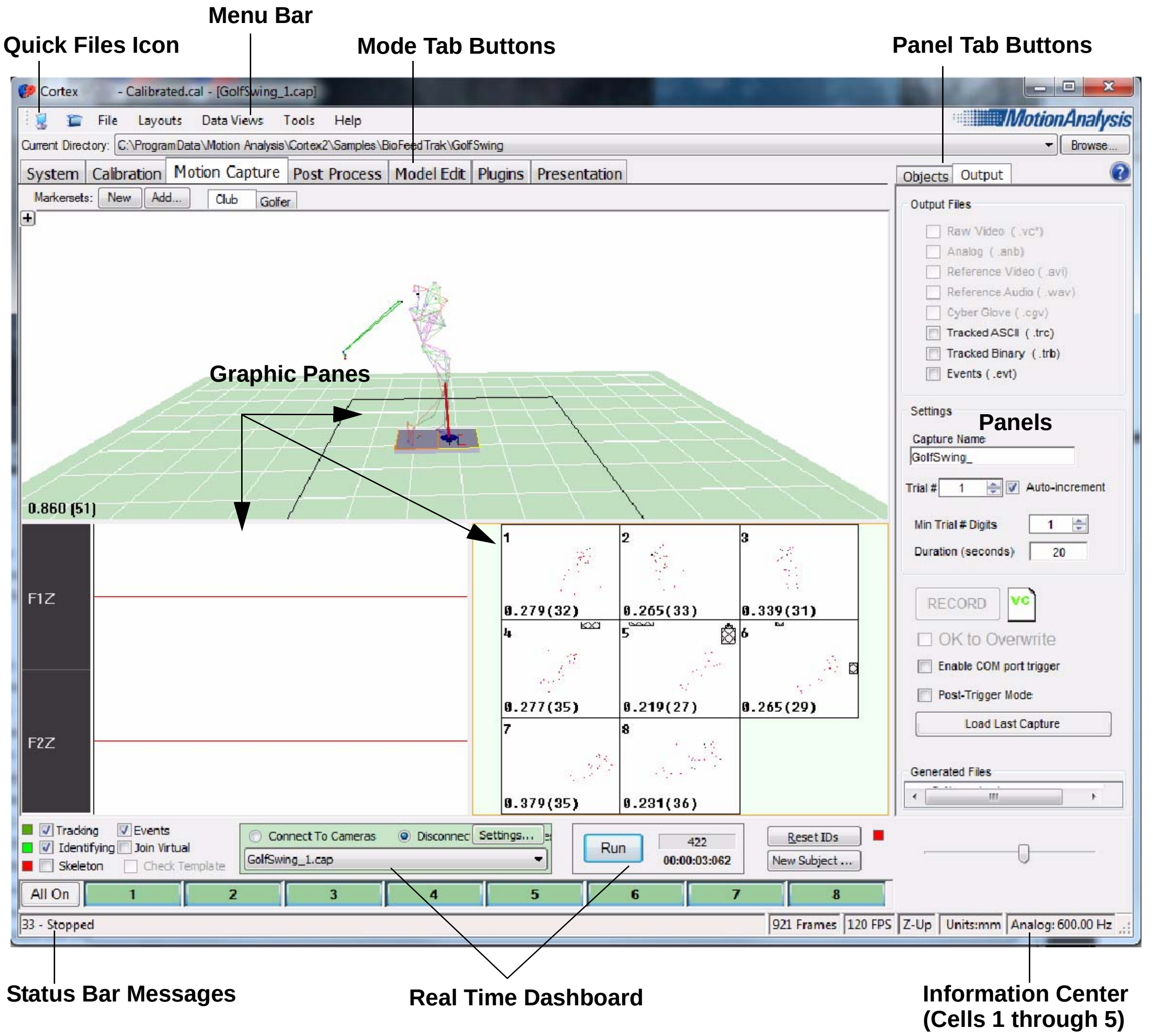
Getting Acquainted With the User Interface

Before using **Cortex** it is necessary to become familiar with the interface and the names of the tools and controls that will be used throughout this manual. The major components are as follows:

1. The Graphics Panes in the center of the screen
2. The Menu Bar in the top-left side
3. The Directory List below the Menu Bar
4. The Mode Buttons along the top left of the screen
5. The Panel Buttons along the top right of the screen
6. The Panels on the right side of the screen
7. The Real Time Dashboard along the bottom of the screen
8. The Post Processing Dashboard replaces the Real Time Dashboard. while the program is in Post Processing mode
9. The Status Bar Messages in the lower-left corner
10. The Information Center in the lower-right corner

An image of the interface is shown in Figure 4-1. Note that multiple 3D views can be rendered simultaneously.

Figure 4-1. Cortex Interface in Real Time Mode


Menu Bar
Quick Files Icon
Mode Tab Buttons
Panel Tab Buttons
Cortex - Calibrated.cal - [GolfSwing_1.cap]
File Layouts Data Views Tools Help
MotionAnalysis
Browse...
System Calibration Motion Capture Post Process Model Edit Plugins Presentation
Objects Output
Markersets: New Add... Club Golfer
Graphic Panes
Panels
Output Files
Raw Video (.vc*)
Analog (.anb)
Reference Video (.avi)
Reference Audio (.wav)
Cyber Glove (.cgv)
Tracked ASCII (.trc)
Tracked Binary (.trb)
Events (.evt)
Settings
RECORD
OK to Overwrite
Enable COM port trigger
Post-Trigger Mode
Load Last Capture
Generated Files
F1Z
F2Z
Tracking Events Identifying Join Virtual Skeleton Check Template
Connect To Cameras Disconnect Settings...
Run
Reset IDs
New Subject ...
All On 1 2 3 4 5 6 7 8
Status Bar Messages
Real Time Dashboard
Information Center
(Cells 1 through 5)

Current Directory: C:\ProgramData\Motion Analysis\Cortex2\Samples\BioFeedTrak\GolfSwing

Capture Name: GolfSwing_

Trial #: 1 ☑ Auto-increment

Min Trial # Digits: 1

Duration (seconds): 20

0.860 (51)

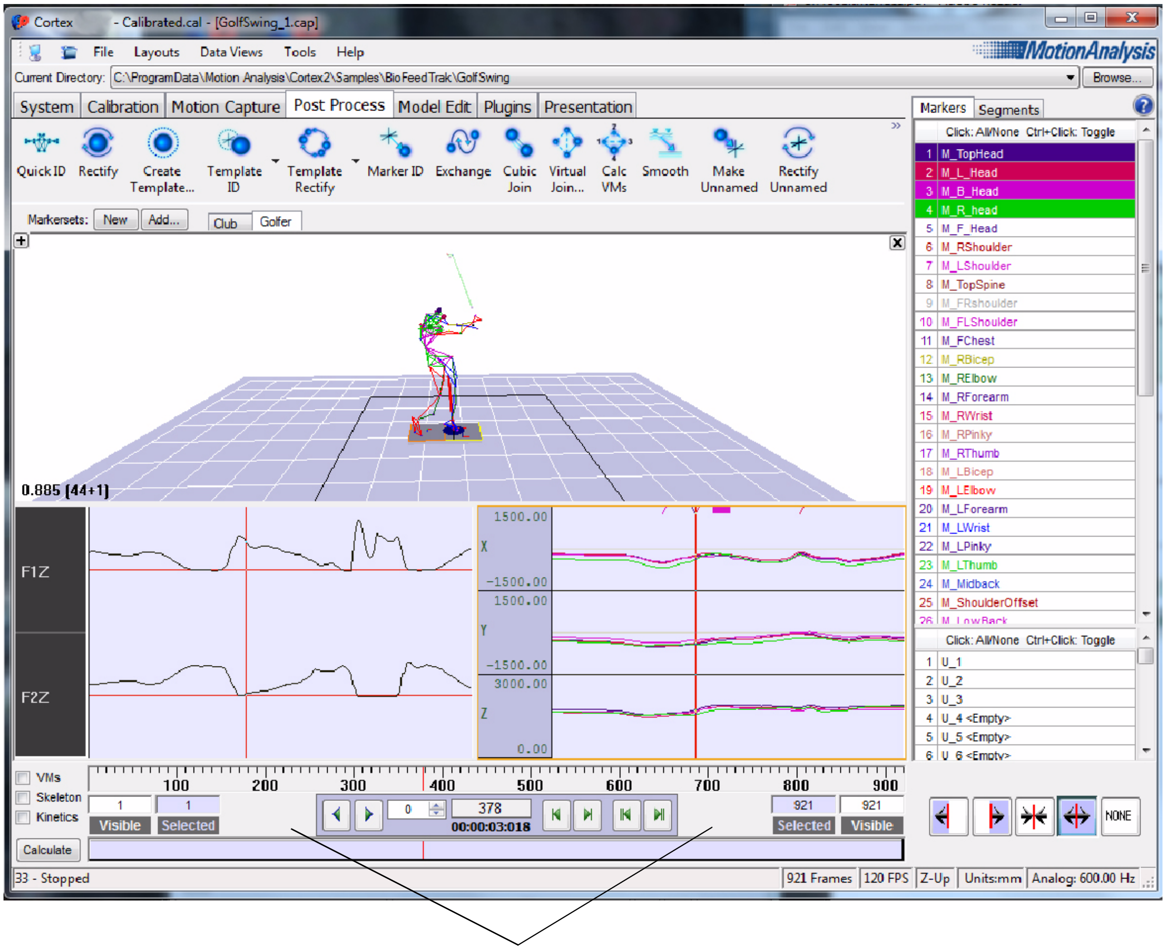
1 0.279(32) 2 0.265(33) 3 0.339(31) 4 0.277(35) 5 0.219(27) 6 0.265(29) 7 0.379(35) 8 0.231(36)

GolfSwing_1.cap

422 00:00:03:062

33 - Stopped | 921 Frames | 120 FPS | Z-Up | Units:mm | Analog: 600.00 Hz

Figure 4-2. Cortex Interface in Post Process Mode


Cortex - Calibrated.cal - [GolfSwing_1.cap]
File
Layouts
Data Views
Tools
Help
MotionAnalysis
Current Directory: C:\ProgramData\Motion Analysis\Cortex2\Samples\BioFeedTrak\GolfSwing
Browse...
System
Calibration
Motion Capture
Post Process
Model Edit
Plugins
Presentation
Quick ID
Rectify
Create Template...
Template ID
Template Rectify
Marker ID
Exchange
Cubic Join
Virtual Join...
Calc VMs
Smooth
Make Unnamed
Rectify Unnamed
Markersets:
New
Add...
Club
Golfer
0.885 [44+1]
F1Z
F2Z
1500.00
X
-1500.00
1500.00
Y
-1500.00
3000.00
Z
0.00
Markers
Segments
Click: All/None Ctrl+Click: Toggle
1 M_TopHead
2 M_L_Head
3 M_B_Head
4 M_R_head
5 M_F_Head
6 M_RShoulder
7 M_LShoulder
8 M_TopSpine
9 M_FRshoulder
10 M_FLShoulder
11 M_FChest
12 M_RBicep
13 M_RElbow
14 M_RForearm
15 M_RWrist
16 M_RPinky
17 M_RThumb
18 M_LBicep
19 M_LElbow
20 M_LForearm
21 M_LWrist
22 M_LPinky
23 M_LThumb
24 M_Midback
25 M_ShoulderOffset
26 M_LowBack
Click: All/None Ctrl+Click: Toggle
1 U_1
2 U_2
3 U_3
4 U_4 <Empty>
5 U_5 <Empty>
6 U_6 <Empty>
VMs
Skeleton
Kinetics
100
200
300
400
500
600
700
800
900
1
1
Visible
Selected
0
378
00:00:03:018
921
921
Selected
Visible
NONE
Calculate
33 - Stopped
921 Frames
120 FPS
Z-Up
Units:mm
Analog: 600.00 Hz

Post Process Dashboard

Menu Bar

The Menu Bar selects the primary items for **Cortex** functionality. These include file management, layout control, data views, tools, and help.

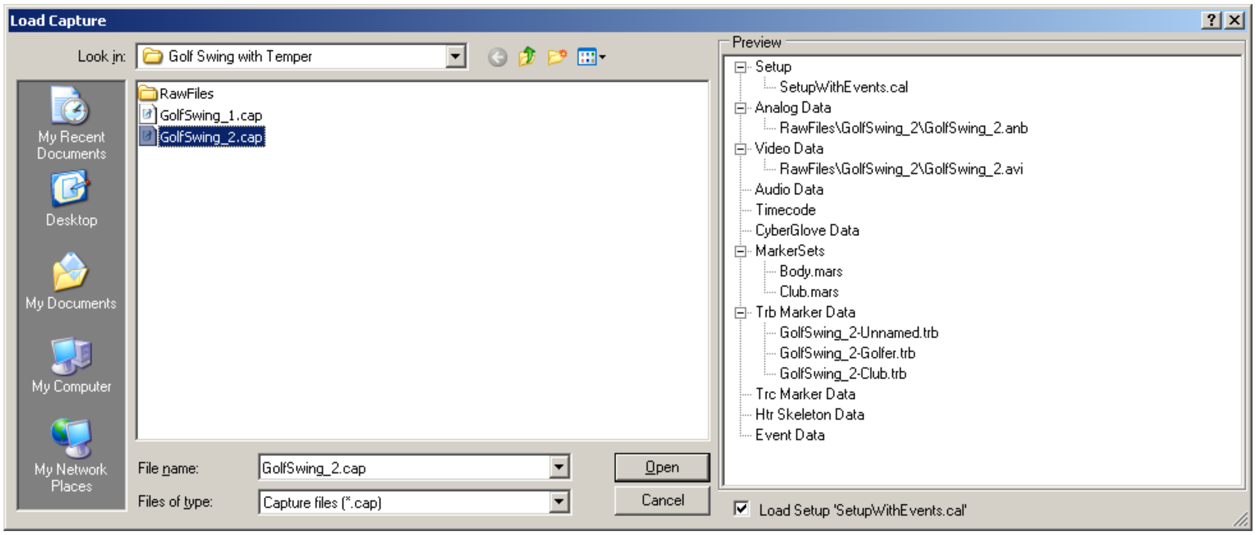
File Menu

The following is a list of the basic operations that can be performed on Setup and Capture Files. All of these items are accessible from the File menu.

File > Load Capture...

Prompts the user to select a Capture for loading into Post Processing. All MarkerSets and data files associated with the capture are loaded. A preview of what files will be loaded is visible on the right hand side of the dialog. Below the preview is a check box which allows the Setup File to be loaded optionally.

Figure 4-3. Load Capture Dialog


Load Capture
Preview
My Recent Documents
Desktop
My Documents
My Computer
My Network Places
RawFiles
GolfSwing_1.cap
GolfSwing_2.cap
Setup
SetupWithEvents.cal
Analog Data
RawFiles\GolfSwing_2\GolfSwing_2.anb
Video Data
RawFiles\GolfSwing_2\GolfSwing_2.avi
Audio Data
Timecode
CyberGlove Data
MarkerSets
Body.mars
Club.mars
Trb Marker Data
GolfSwing_2-Unnamed.trb
GolfSwing_2-Golfer.trb
GolfSwing_2-Club.trb
Trc Marker Data
Htr Skeleton Data
Event Data
Open
Cancel

Look in: Golf Swing with Temper

File name: GolfSwing_2.cap

Files of type: Capture files (*.cap)

☑ Load Setup 'SetupWithEvents.cal'

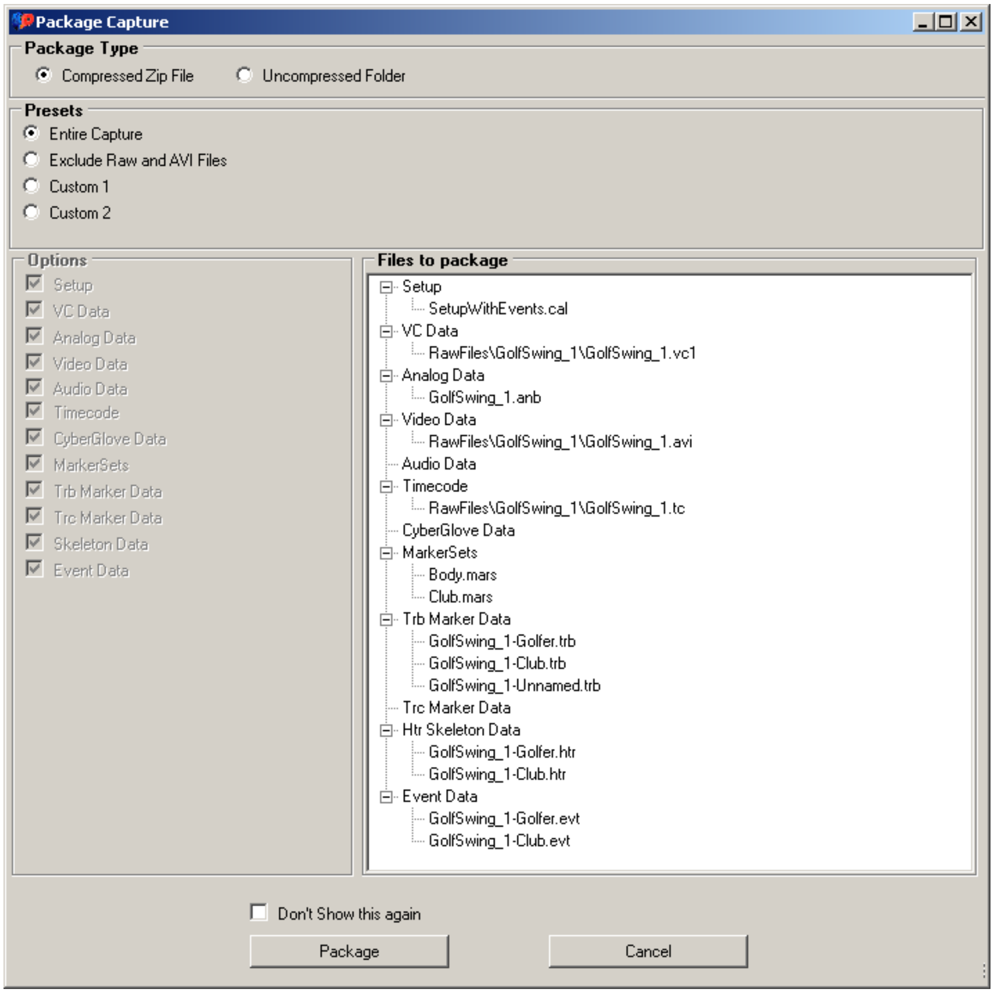
File > Save Capture Saves the Capture currently loaded into Post Processing. All MarkerSets and data files associated with the capture are loaded. The Setup File associated with the capture will also be saved.

File > Save Capture As... Save the Capture currently loaded in Post Processing under a new name. New processed files (trb, trc, htr, evt) are generated for use by the new Capture. The new Capture will refer to same raw files (vc, anb, tc, avi, wav, cgv) that the original one referred to. Since the raw files are not duplicated when doing a Save As, it is important to be careful when deleting raw files.

File > Package Capture & Package Capture > With Options...

A capture is often composed of several files, not necessarily in the same folder. Package Capture provides the user with an interface that collects files in the Post Process capture, so that they can be moved to a new location/computer. There are options for selecting which files should be collected. This is useful since e-mailing/transferring large raw files is often impractical. There are two types of packages that can be created: moving the files to a folder, and creating a zip file.Once the packaging options are set, it is possible to select "Don't show this again", which will prevent the options dialog from displaying when "Package Capture is selected". Selected **Package Capture > with options...** forces the dialog to again be displayed.

Figure 4-4. Package Capture Interface



Package Capture

Package Type

● Compressed Zip File ○ Uncompressed Folder

Presets

● Entire Capture
○ Exclude Raw and AVI Files
○ Custom 1
○ Custom 2

Options

☑ Setup
☑ VC Data
☑ Analog Data
☑ Video Data
☑ Audio Data
☑ Timecode
☑ CyberGlove Data
☑ MarkerSets
☑ Trb Marker Data
☑ Trc Marker Data
☑ Skeleton Data
☑ Event Data

Files to package

- Setup
  - SetupWithEvents.cal
- VC Data
  - RawFiles\GolfSwing_1\GolfSwing_1.vc1
- Analog Data
  - GolfSwing_1.anb
- Video Data
  - RawFiles\GolfSwing_1\GolfSwing_1.avi
- Audio Data
- Timecode
  - RawFiles\GolfSwing_1\GolfSwing_1.tc
- CyberGlove Data
- MarkerSets
  - Body.mars
  - Club.mars
- Trb Marker Data
  - GolfSwing_1-Golfer.trb
  - GolfSwing_1-Club.trb
  - GolfSwing_1-Unnamed.trb
- Trc Marker Data
- Htr Skeleton Data
  - GolfSwing_1-Golfer.htr
  - GolfSwing_1-Club.htr
- Event Data
  - GolfSwing_1-Golfer.evt
  - GolfSwing_1-Club.evt

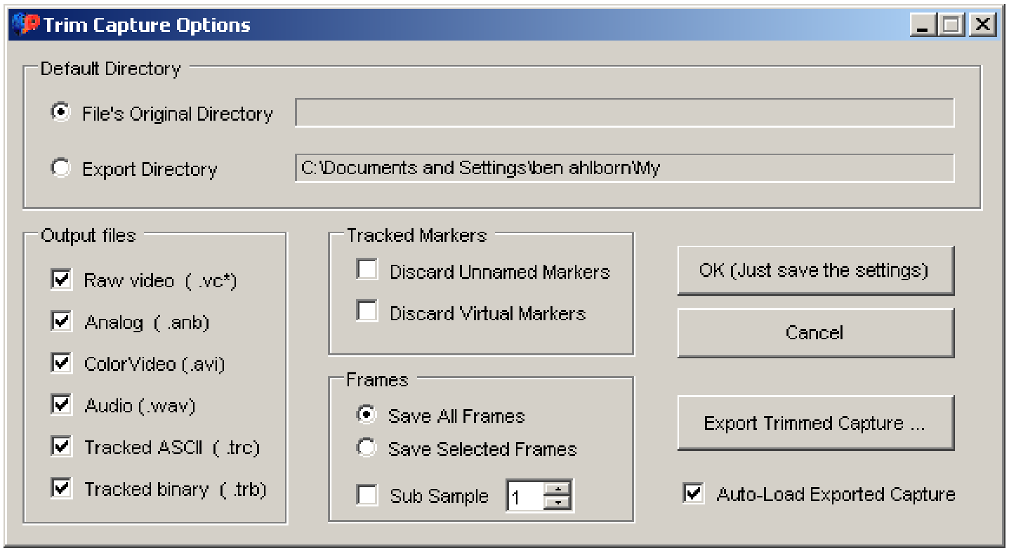
☐ Don't Show this again

Note: You may undo the “Don’t Show this again” function by selecting the **Welcome to Cortex dialog enables check-box** in the **Tools > Settings > Misc** panel.

File > Trim Capture W/ Options...

Provides an interface for altering the Post Process Capture. This includes changing which files are part of the capture (TRB vs TRC), discarding portions of the data (virtual and unnamed marker data), trimming frames from the capture, and sub-sampling the capture.

Figure 4-5. Trim Capture Options Interface



Default Directory
- ● File's Original Directory
- ○ Export Directory C:\Documents and Settings\ben ahlborn\My

Output files
- ☑ Raw video (.vc*)
- ☑ Analog (.anb)
- ☑ ColorVideo (.avi)
- ☑ Audio (.wav)
- ☑ Tracked ASCII (.trc)
- ☑ Tracked binary (.trb)

Tracked Markers
- ☐ Discard Unnamed Markers
- ☐ Discard Virtual Markers

Frames
- ● Save All Frames
- ○ Save Selected Frames
- ☐ Sub Sample 1

☑ Auto-Load Exported Capture

File > Close Capture

Unloads the Post Processing Capture. This includes unloading all MarkerSets and data files, but the Setup information is left in place.

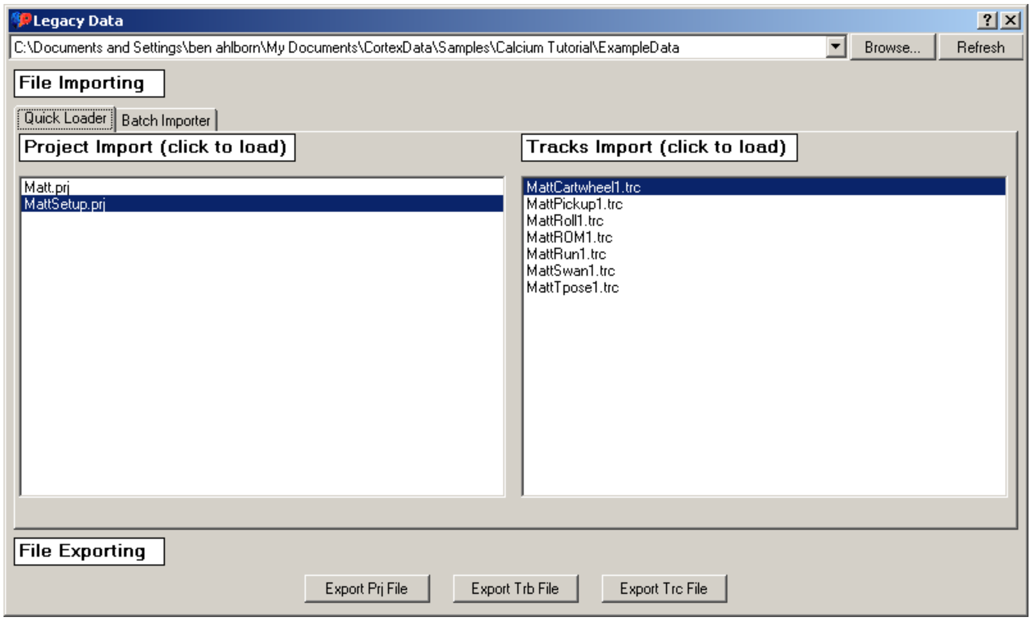
File > Import/Export Legacy Data

This is a tool which provides compatibility between EVaRT, Cortex 1, and Cortex 2. For importing this tool has two modes: Quick Loader and Batch Loader. Exporting provides three operations: Export Prj File, Export Trb File, Export Trc File.

Quick Loader

The quick loader allows one-click loading of legacy project files and tracks files. When a project file is selected, all post processing data is unloaded. The Setup contained in the project file is loaded, and any MarkerSet contained in the project file is loaded into Live Mode and Post Processing. When a tracks file is selected, the named and unnamed data it contains is loaded into Post Process, along with any associated data files (anb, htr, etc) just as was the case in **EVaRT** and **Cortex 1**. After this data is loaded, it can be saved into a **Cortex 2** capture using the **Save Capture As File** menu option.

Figure 4-6. Quick Loader Interface


Legacy Data
Browse...
Refresh
File Importing
Quick Loader
Batch Importer
Project Import (click to load)
Tracks Import (click to load)
File Exporting
Export Prj File
Export Trb File
Export Trc File

C:\Documents and Settings\ben ahlborn\My Documents\CortexData\Samples\Calcium Tutorial\ExampleData

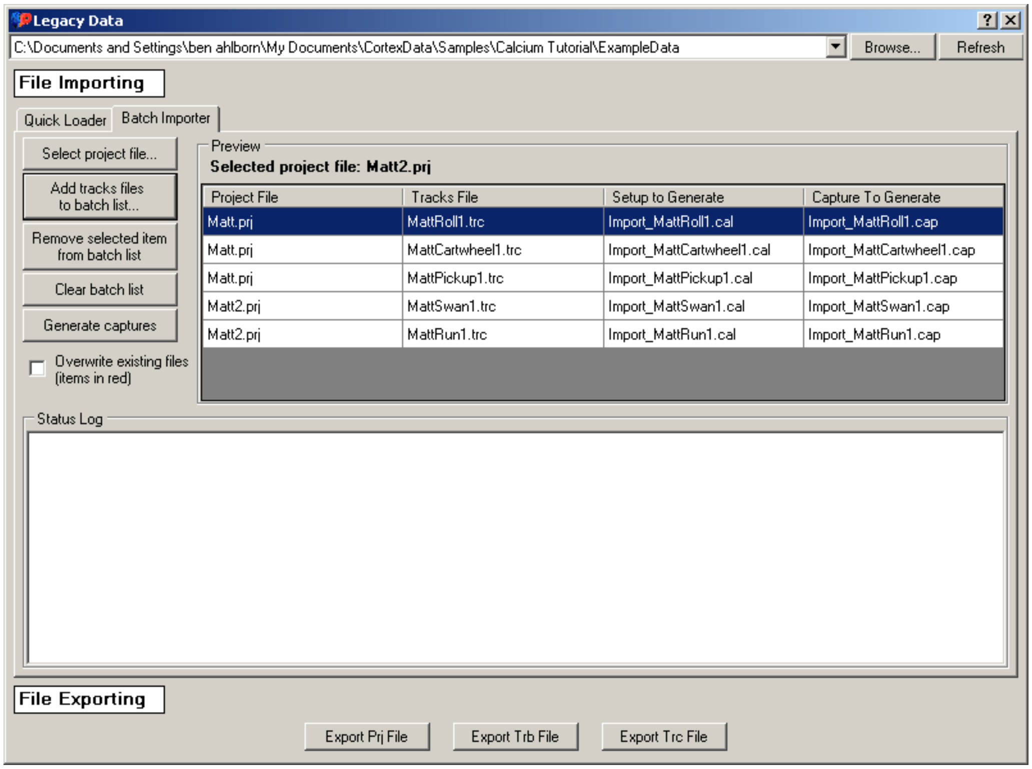
Matt.prj
MattSetup.prj

MattCartwheel1.trc
MattPickup1.trc
MattRoll1.trc
MattROM1.trc
MattRun1.trc
MattSwan1.trc
MattTpose1.trc

Batch Loader

The batch loader is used for converting groups of files into captures. This is accomplished by creating a list of project-tracks file pairs. Each pair is then loaded, and has a Capture saved for it. Creating a pair begins by selecting a project file. Once a project file is loaded, a number of tracks files can be associated to this project. A new project file can then be selected and tracks associated with it. The files that will be generated are displayed in the "Preview" area, along with the selected project file. Once all pairs in the current folder are setup, the "Generate Captures" button will go through the list and generate a series of Captures and Setup Files. Capture/Setup Files that already exist are not overwritten unless the "Overwrite existing items" box is checked. The batch importer has a status log to indicate the progress being made. When the batching is done, the last Capture in the list will still be loaded.

Figure 4-7. Batch Importer Interface



C:\Documents and Settings\ben ahlborn\My Documents\CortexData\Samples\Calcium Tutorial\ExampleData

Selected project file: Matt2.prj

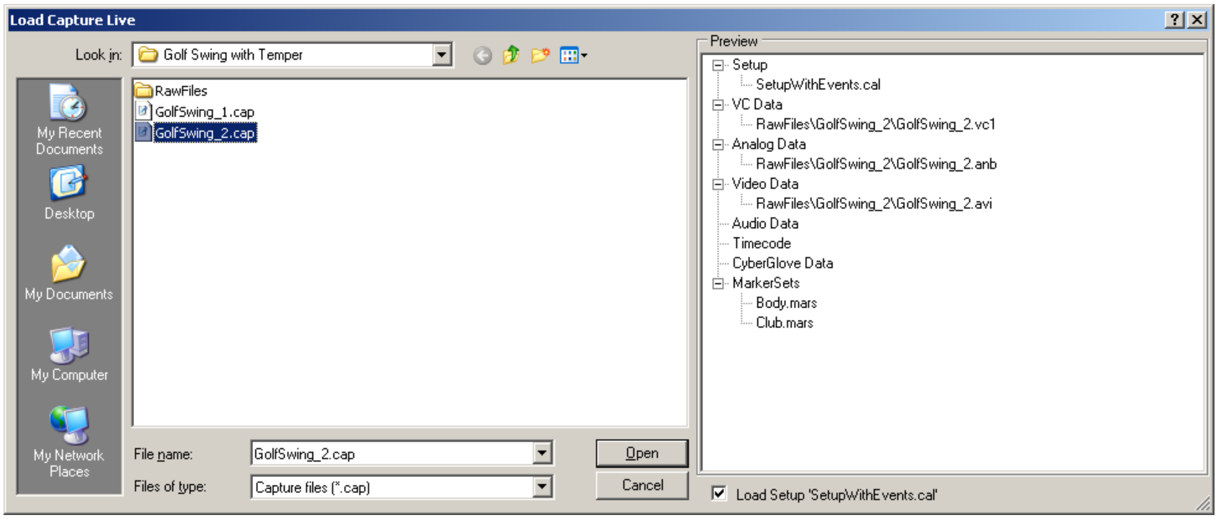
Project File	Tracks File	Setup to Generate	Capture To Generate
Matt.prj	MattRoll1.trc	Import_MattRoll1.cal	Import_MattRoll1.cap
Matt.prj	MattCartwheel1.trc	Import_MattCartwheel1.cal	Import_MattCartwheel1.cap
Matt.prj	MattPickup1.trc	Import_MattPickup1.cal	Import_MattPickup1.cap
Matt2.prj	MattSwan1.trc	Import_MattSwan1.cal	Import_MattSwan1.cap
Matt2.prj	MattRun1.trc	Import_MattRun1.cal	Import_MattRun1.cap

Legacy Data
? X
Browse...
Refresh
File Importing
Quick Loader
Batch Importer
Select project file...
Add tracks files to batch list...
Remove selected item from batch list
Clear batch list
Generate captures
☐ Overwrite existing files (items in red)
Preview
Status Log
File Exporting
Export Prj File
Export Trb File
Export Trc File

File > Load Capture (Live)...

Prompts the user to select a capture, for which portions will be loaded into Live Mode. The MarkerSets, and raw files are loaded for (re)recording. A preview of what files will be loaded is visible on the right hand side of the dialog. Below the preview is a check box which allows the Setup File to be loaded optionally. This can be useful for re-tracking pre-recorded Captures from raw data (VC) files.

Figure 4-8. Load Capture Live Dialog



Look in: Golf Swing with Temper

RawFiles
GolfSwing_1.cap
GolfSwing_2.cap

File name: GolfSwing_2.cap
Files of type: Capture files (*.cap)

- Setup
  - SetupWithEvents.cal
- VC Data
  - RawFiles\GolfSwing_2\GolfSwing_2.vc1
- Analog Data
  - RawFiles\GolfSwing_2\GolfSwing_2.anb
- Video Data
  - RawFiles\GolfSwing_2\GolfSwing_2.avi
- Audio Data
- Timecode
- CyberGlove Data
- MarkerSets
  - Body.mars
  - Club.mars

☑ Load Setup 'SetupWithEvents.cal'

File > Load Setup...

Prompts the user to select a Setup File (.cal), from which a Setup will be loaded. This includes the camera setup, analog setup, force plate configuration, tracking parameters and most other things that were previously stored in Cortex project or capture files. If a Capture is already loaded into Post Processing, that Capture will now use the newly loaded Setup File.

File > Save Setup

Saves the current Setup into the .cal file that it was loaded from. If a .cal file isn't loaded, the Save Setup As dialog is opened.

File > Save Setup As...

Prompts the user to select a new Setup File (.cal) to save the current Setup into. This file is now the currently loaded Setup File (shown in the Cortex 2 title bar). If a Capture is already loaded into Post Processing, that Capture will now use the newly saved Setup File.

File > Load System Setup

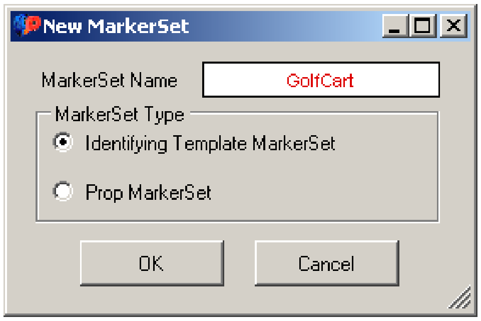
Used to manually load the System Setup, which contains all the elements of the Cal file.

File > Save System Setup

Used to manually save the System Setup, which contains all the elements of the Cal file.

File > New MarkerSet...	Provides a dialog for creating a new MarkerSet. A MarkerSet name is required, as well as the type of MarkerSet (Template vs Prop). The MarkerSet name is not necessarily the same as the file that the MarkerSet will be stored in. It is the MarkerSet name that is visible in the TreeView and also which can be edited when modifying a template. This MarkerSet is added to the MarkerSet list for which ever mode Cortex is in (Live vs Post Processing).

Figure 4-9. New MarkerSet Interface



MarkerSet Name: GolfCart

MarkerSet Type

● Identifying Template MarkerSet

○ Prop MarkerSet

File > Add MarkerSet...	Prompts the user to select a MarkerSet file (.mars) and adds the MarkerSet in the selected file to the MarkerSet list for the current program mode.
File > Remove MarkerSet	Removes the selected MarkerSet from the MarkerSet list for the current program mode. In Post Processing, and identified marker data for the MarkerSet is made unnamed.
File > Replace MarkerSet...	Prompts the user to choose a MarkerSet file that replaces selected MarkerSet in the MarkerSet list for the current program mode. The replacement MarkerSet must have the same number of marker definitions as the MarkerSet that is being replaced. All skeleton and event data for the MarkerSet is cleared. This can be useful for switching between versions of a MarkerSet, or the same template with different skeleton types.
File > Save MarkerSet	Saves the selected MarkerSet into the .mars file that it was loaded from. If the MarkerSet is not yet associated with a file, then the Save MarkerSet As prompt is displayed.
File > Save MarkerSet As...	Saves the selected MarkerSet into a new .mars file. This is the file that now is referred to in any program modes that reference this MarkerSet. Additionally, if this MarkerSet is part of a Capture loaded in Post Processing, the Capture will now refer to the new file name.
File > Load Camera Calibration...	Loads only the calibration from a setup (.cal) file or legacy project (.prj) file.

File > Load Analog Setup...

Loads only the analog setup from a setup (.cal) or legacy project (.prj) file. Analog setup includes forceplate channel names, EMG channel names and other analog data to be digitized by Cortex during data collection.

File > Select Raw Video File...

Allows you to select the legacy camera 1 file (*.vc1) for re-tracking or recording a new capture. For Cortex 2 captures, you should use File->Load Capture (Live) for the same function.

File > Export

Export HTR File...

Exports a file in HTR format, which is commonly used in the animation software packages.

Export C3D File...

Exports marker positions and analog data in an open sourced file format viewable by many different software packages.

Export CRC File...

CRC (Centroid Row Column) data are the 2D data points in ASCII text format. Usable by advanced users who want to reconstruct 3D positions of markers using their own software, in post process mode only.

Export Kinetics File...

Exports Kinematics (joint angles) and Kinetics (forces and moments) data into a single .kin file, which is a tab-deliminated ASCII file easily viewed in Microsoft Excel™ spreadsheets.

Export Forces File...

Exports ASCII files containing force plate data. This uses your current forcepla.cal file and converts the raw force plate data into calibrated forces. The units used are Newtons and Newton-Meters and each line in the file equates to one analog sample.

Export ANC

Exports binary formatted Analog binary data (.ANB) into an ASCII viewable format (.ANC – Analog Numbered Columns).

File > Skeleton Definitions

Import Skeleton (.mod) File...

Imports a previously saved Calcium/Solver model definition into the current markerset (skeleton, joint types and marker attachments). This replaces the existing definition if there is one. The markers referenced in the .mod file must match the marker names in the current markerset.

Export Skeleton (.mod) File...

Saves the current Calcium/Solver model information (skeleton, joint types, marker attachments and skeleton pose) into a .mod file. This file is used by SoNIC to describe how streaming markersets are to be solved. This file can also be imported by Cortex onto a matching marker set (same marker names, the markerset name can be different).

Create Skeleton from HTR File...

Creates a skeleton definition from the HTR file. The joints are all set to the type "Fixed" and there are no attachments specified. The HTR file is typically created by exporting it from an animation package such as Maya. This deletes and replaces any existing model information. Exported HTR files are not automatically loaded as part of the capture unless you explicitly save the capture and list it in the **Tools > Settings > File Structure** tab.

Update Skeleton from HTR File...

Updates the pose of the current model skeleton with the information in the given HTR file. The skeleton names in the HTR file must match the names in the current model skeleton. This is typically used to change the pose of the skeleton (joint orientations, offsets and lengths) without having to re-specify all the joint types and attachments.

Create SIMM Calcium Skeleton (JNT File)...

Calculates and stores a JNT file with the same name as the MarkerSet file which is scaled to the subject’s bone sizes.

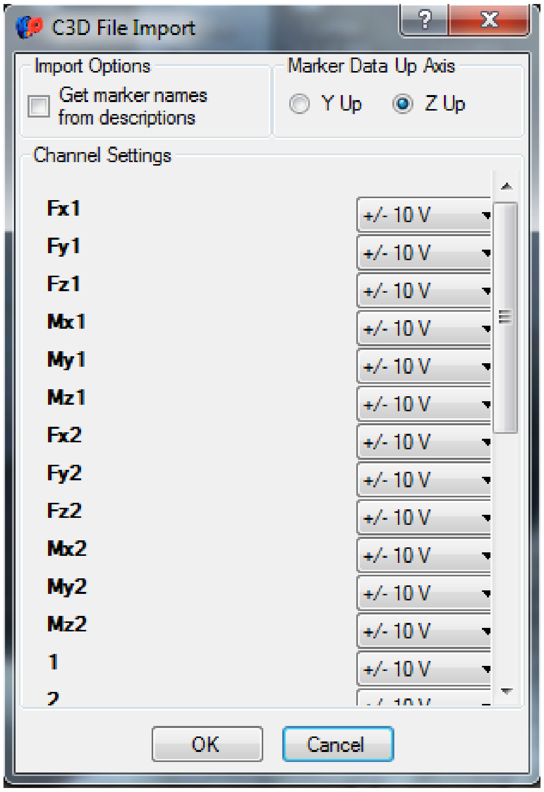
Export SIMM Motion File...

Exports a motion (.MOT) file that can be loaded and used in SIMM – Software for Musculoskeleton Modeling.

File > Import C3D File...

C3D is a file format used by some applications for storing motion and analog data. The C3D File Import Dialog allows data stored in this format to be imported into Cortex. Some information about the capture configuration is needed to convert C3D into the corresponding MAC file types. Note that a separate folder and capture file (.cap) is created with the contents of the c3d file.

Figure 4-10. Import C3D File Interface


C3D File Import
?
X
Import Options
Marker Data Up Axis
Channel Settings
OK
Cancel

☐ Get marker names from descriptions

○ Y Up ● Z Up

Fx1	+/- 10 V
Fy1	+/- 10 V
Fz1	+/- 10 V
Mx1	+/- 10 V
My1	+/- 10 V
Mz1	+/- 10 V
Fx2	+/- 10 V
Fy2	+/- 10 V
Fz2	+/- 10 V
Mx2	+/- 10 V
My2	+/- 10 V
Mz2	+/- 10 V
1	+/- 10 V
2	+/- 10 V

File > Import ANC File

Imports ASCII viewable formatted Analog data (.anc).

File > Profile Manager

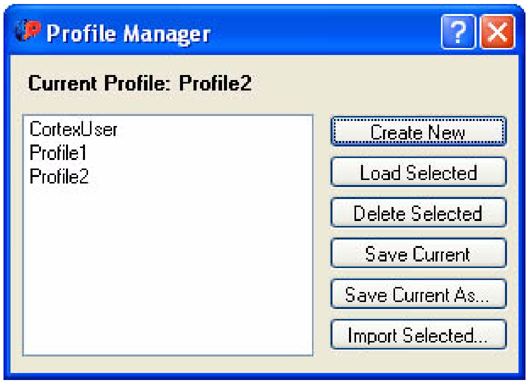
The Profile Manager opens a dialog which manages the customized settings for individual users. These customized settings include the following:

- Hotkeys
- Colors
- Layouts and Data Views
- Post Process Tool Strip

The Profile Manager dialog has three main components:

- Current profile set for manipulation (top)
- List of all available profiles (left side)
- Profile manipulation buttons (right side)

Figure 4-11. Profile Manager



Current Profile: Profile2

CortexUser
Profile1
Profile2

Create New

A prompt to enter a profile name will be displayed. A profile with that name and the default settings will be created. This will be set as the current profile.

Load Selected

This will load whatever profile is selected from the profile list and make it the current profile.

Delete Selected

This will delete the profile selected in the profile list. Deleting the current profile is not allowed.

Save Current

This will save the current profile. Saving is also done automatically when the application closes.

Save Current As…

A prompt to enter a profile name will be displayed. A profile with that name and the current settings will be created and made the current profile. Note: the current settings are not necessarily the same as the settings for the current profile. If any settings changes have been made prior to selecting Save As, these will be reflected in the new profile and not the current profile.

Import Selected…

This launches the profile import dialog. This allows portions of another profile to be loaded for use with the current profile.

File > Exit

Allows you to exit the **Cortex** software. Make sure you have saved the current capture files.

Layouts Menu

The items in this menu are generally self explanatory.

Preserve Layouts

When checked, Cortex remembers the different layouts for each of the mode tabs (System, Calibration, Motion Capture, Post Process, Model Edit, Plugins and Presentation). When un-checked, it keeps the same layout configuration when you move to the different mode tabs.

Data Views Menu

The **Cortex** interface can accommodate up to four simultaneously open data views and can be resized with the mouse to fit the panes however you desire. You can view combinations of six different graphical panes, which include:

Reference Video F1

Displays the live action in a capture volume or a replay of an AVI file. You will need to have a DV (Digital Video) camera connected to the Host computer’s 1394 Firewire port to see the live video in this window.

2-D Display F2

Displays a 2D image of the markers and their centroids.

3-D Display F3

Displays a moving 3D stick figure showing named markers, virtual markers, linkages and/or a skeleton.

Marker XYZ Graphs F4

Displays graphs depicting the marker’s positions in each frame.

Analog Display F5

Displays analog data graphs representing the force plate’s output.

Skeleton Graphs F6

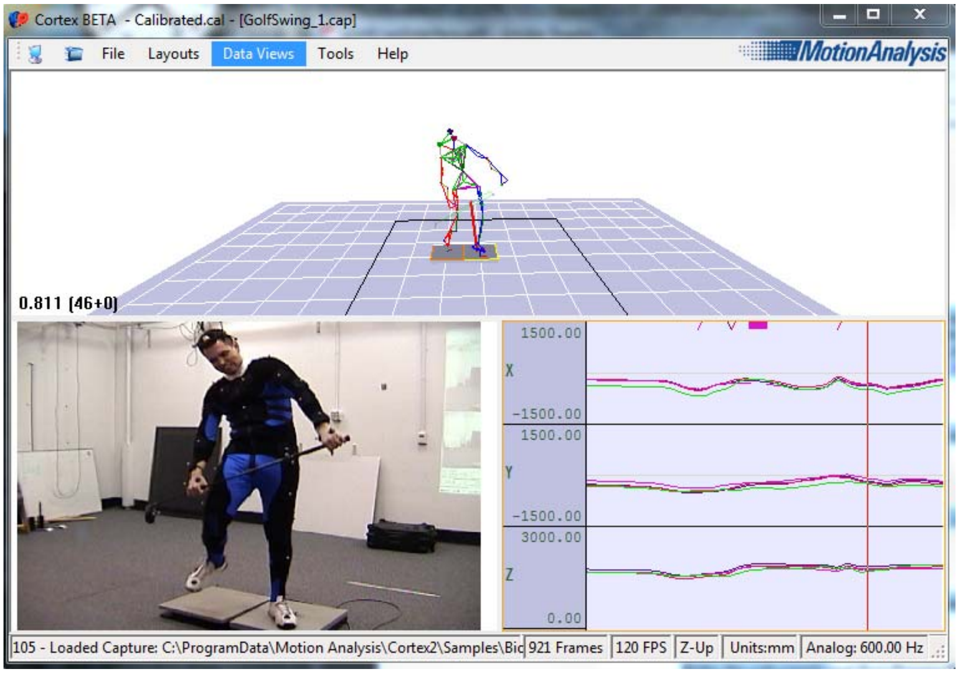
Displays the following data graphs for selected skeletal segments:

- Kinematics
- Forces
- Moments
- Linear Movement
- Angular Movement

- Solver Stats

Analysis Graphs F7	Calculates and displays angles between markers, distances between markers, and position, velocity, and acceleration of a marker, or groups of selected markers. Results can be saved as ASCII Time Series (.ts) files. For more information.
Doc View F8	Provides an interface to open and edit most text based files and display them within the **Cortex** software. Used for making Presentations with Motion Composer.
Web View F9	Provides an interface to open, display, and edit HTML files within the **Cortex** software. Used for making Presentations with Motion Composer.
Presentation Graphs F10	For making high quality graphs of all kinds of data that Cortex records or calculates. Includes marker data, analog voltages, force and angle data and calculations based on these data. User specifies the number of graphs per page, the labels and fonts, auto or fixed scaling and other items. Presentation Graphs can be used in Motion Composer presentations and be printed. Graph formats are stored in .graph files
Empty View F11	Leaves a blank space for the selected pane.
Graphics Only (Ctrl+G)	Hides the side panels and dashboards, shows only the main graphics panels. Good for eliminating the software controls for presentations or better viewing of your data. Also available as a toggle on hotkey 9.

Figure 4-12. Graphics Only View



Cortex BETA - Calibrated.cal - [GolfSwing_1.cap]

105 - Loaded Capture: C:\ProgramData\Motion Analysis\Cortex2\Samples\Bi | 921 Frames | 120 FPS | Z-Up | Units:mm | Analog: 600.00 Hz

Tools Menu

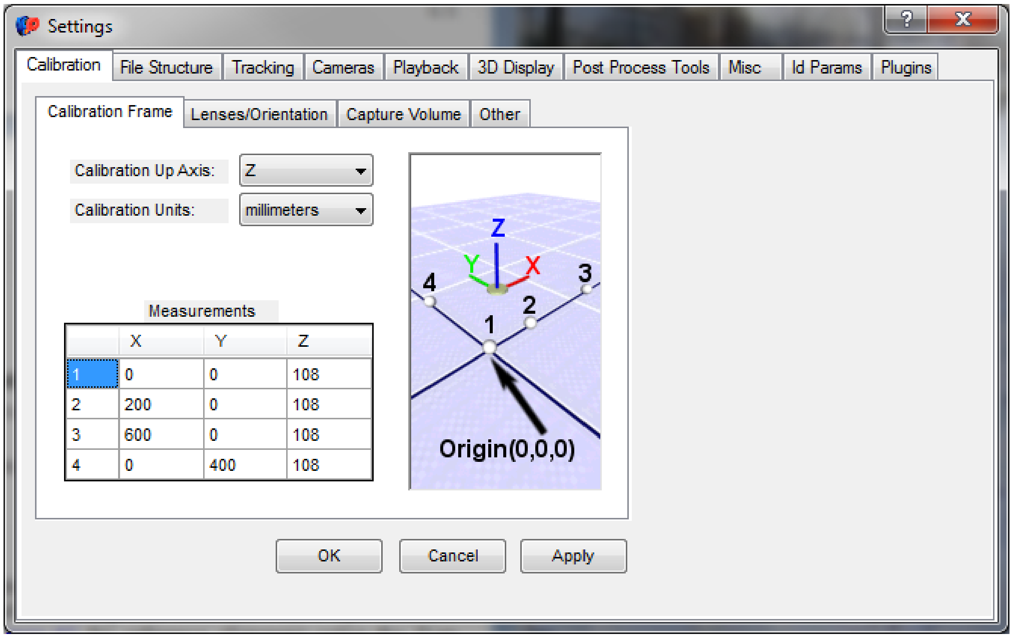
The Tools menu gives access to various functions within the **Cortex** software. Many of these functions are also available in other sections of the user interface.

Tools > Settings > Calibration Tab

Before collecting your first seed calibration, these Calibration Settings must be completed. Once the values are filled out, press Apply and return to the Calibration window in **Cortex**.

Calibration Tab > Calibration Frame – Required Settings

Figure 4-13. Calibration Frame Interface


Settings
Calibration
File Structure
Tracking
Cameras
Playback
3D Display
Post Process Tools
Misc
Id Params
Plugins
Calibration Frame
Lenses/Orientation
Capture Volume
Other
Z
Y
X
4
3
2
1
Origin(0,0,0)
OK
Cancel
Apply

Calibration Up Axis: Z

Calibration Units: millimeters

Measurements

	X	Y	Z
1	0	0	108
2	200	0	108
3	600	0	108
4	0	400	108

The settings here determine the coordinate system of your capture volume. This is where you enter the measurements of the calibration L-frame, the Up-Axis, and your system units.

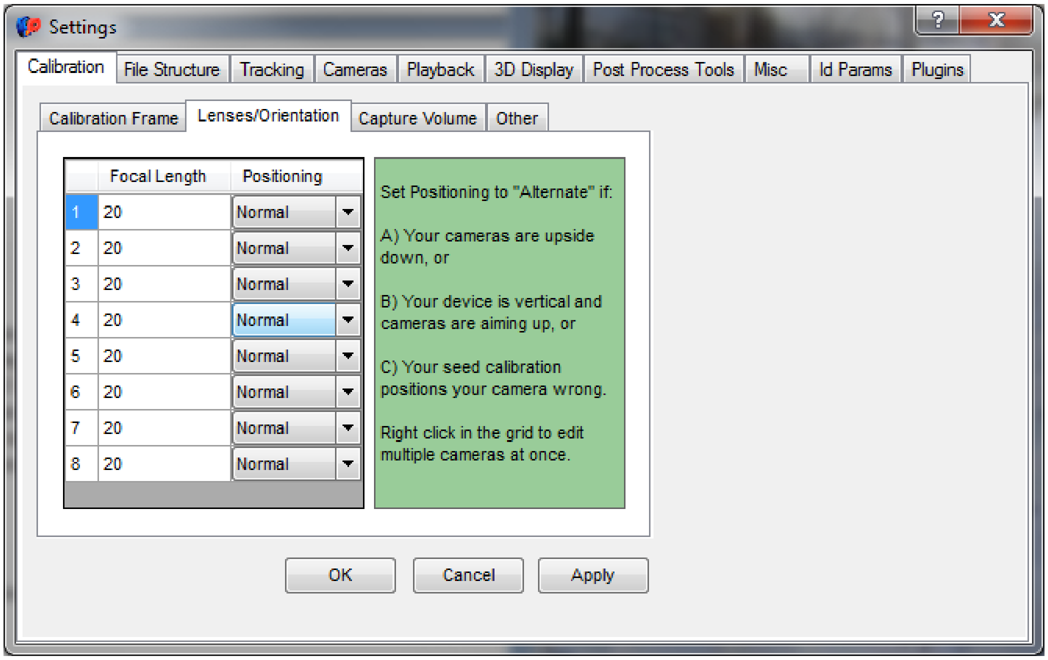
L-Frame Measurements

The distances from the volume's origin are measured and are entered into the Measurements spaces. Observe the right-hand rule and make sure that you enter the data correctly. In the Z-Up example, points 1, 2, and 3 are on the +X axis, and point 4 is on the +Y axis, but adjust this accordingly if your Up-Axis is different. The vertical distances are the distance from the center of the markers to the floor. Click on the other tabs and fill in the values accordingly.

Note: You can make your own calibration L-frame by placing four markers on the floor and measuring their locations with a tape measure. Measurements should be within 1 mm. Selecting a different calibration up-axis will show the correct view on how to set up your calibration L-frame.

Calibration Tab > Lenses/Orientation – Required Settings

Figure 4-14. Lenses/Orientation Settings


Settings
Calibration
File Structure
Tracking
Cameras
Playback
3D Display
Post Process Tools
Misc
Id Params
Plugins
Calibration Frame
Lenses/Orientation
Capture Volume
Other
OK
Cancel
Apply

	Focal Length	Positioning
1	20	Normal
2	20	Normal
3	20	Normal
4	20	Normal
5	20	Normal
6	20	Normal
7	20	Normal
8	20	Normal

Set Positioning to "Alternate" if:

A) Your cameras are upside down, or

B) Your device is vertical and cameras are aiming up, or

C) Your seed calibration positions your camera wrong.

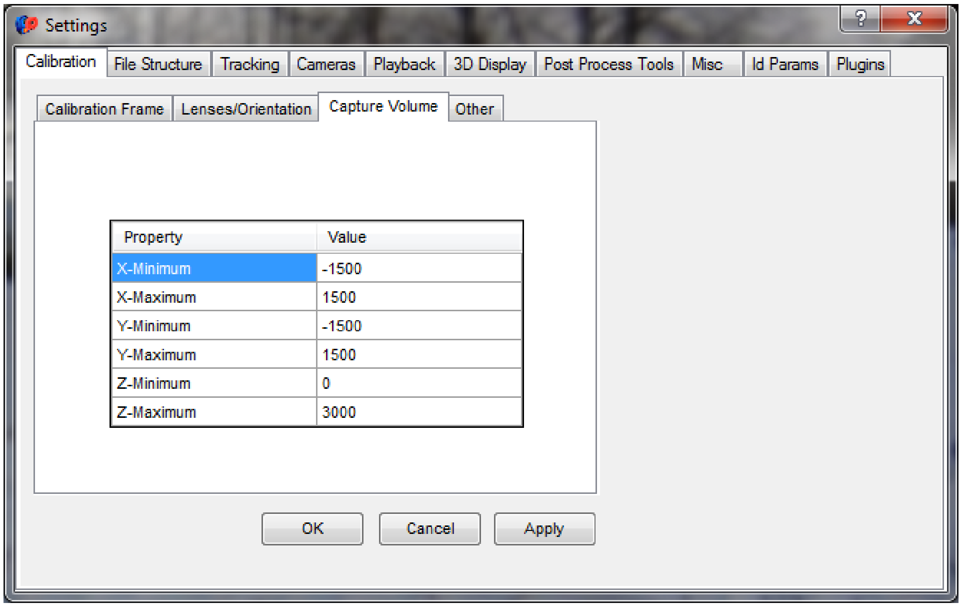
Right click in the grid to edit multiple cameras at once.

These settings are used to set the focal length and orientation of each camera, as used at the start of the wand calibration procedure. After the wand calibration, the actual focal length of the lens is calculated exactly and can be stored in your capture file. The focal length should be set to something fairly close to the actual focal length of the lens (e.g. 6 for 6 mm lenses). The positioning for the camera should be **Normal** if the camera is “upright” (top if the camera is within ±90 degrees of perpendicular to the floor). Otherwise the camera positioning should be set to **Alternate.**

If you use the **Camera Aiming** check box in the Calibrate panel, the focal length entries should first be set to be nominally correct values (e.g. 6 for 6 mm lenses). When using the **Show Camera Field of View** flag in the 3D display, the value from this table is used to compute the view frustum of the camera.

Calibration Tab > Capture Volume

Figure 4-15. Capture Volume Tab


Settings
Calibration
File Structure
Tracking
Cameras
Playback
3D Display
Post Process Tools
Misc
Id Params
Plugins
Calibration Frame
Lenses/Orientation
Capture Volume
Other
OK
Cancel
Apply

Property	Value
X-Minimum	-1500
X-Maximum	1500
Y-Minimum	-1500
Y-Maximum	1500
Z-Minimum	0
Z-Maximum	3000

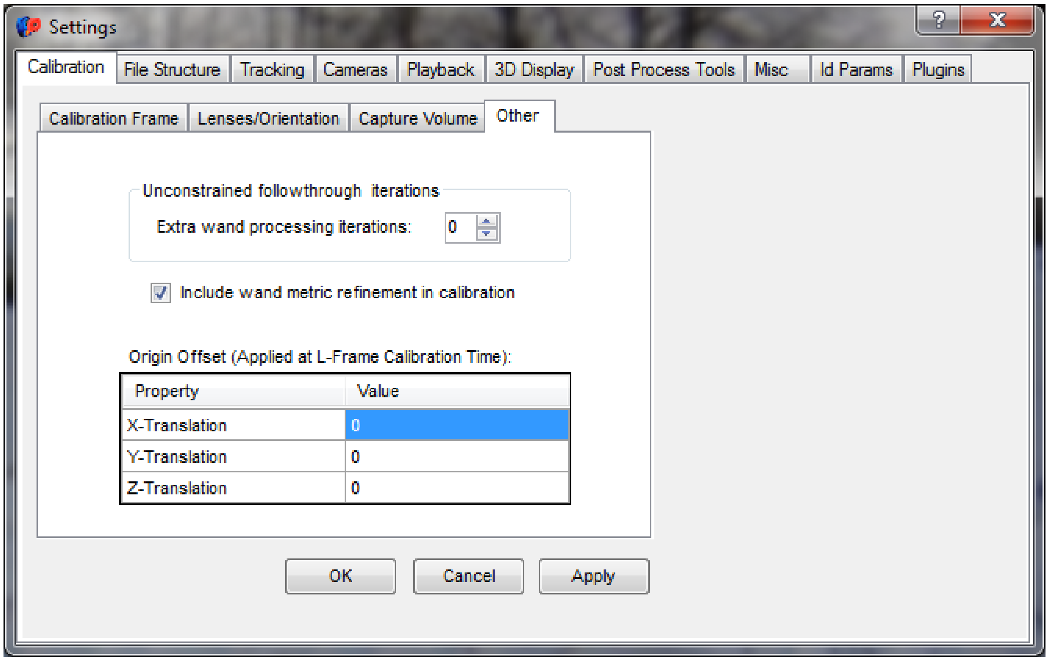
Here you can specify the size of your capture volume. The measurement units are the same as the specified calibration units (see Calibration Frame). This can be used to provide visual feedback in the 3d display. It does not affect the tracked data in any manner.

Note: In the **Plugins > X** panel, the Delete Outside Volume feature will delete any marker data outside of the capture volume.

Note: The Volume display is used as a visual aid when aiming the cameras in real time during setup.

Calibration Tab > Other

Figure 4-16. Calibration > Other (Settings) Tab


Settings
Calibration
File Structure
Tracking
Cameras
Playback
3D Display
Post Process Tools
Misc
Id Params
Plugins
Calibration Frame
Lenses/Orientation
Capture Volume
Other
OK
Cancel
Apply

Unconstrained followthrough iterations

Extra wand processing iterations: 0

☑ Include wand metric refinement in calibration

Origin Offset (Applied at L-Frame Calibration Time):

Property	Value
X-Translation	0
Y-Translation	0
Z-Translation	0

Unconstrained Follow-Through Iterations

This relaxes the wand-length constraint and executes additional measurement iterations. These relaxed iterations are the equivalent of doing consecutive Refine Calibrations, using the want data.

Include wand metric refinement in calibration

This explicitly requires that the wand capture procedure of having the wand oriented in all three coordinate axes (x,y,z) is followed. The resulting calibration calculation converges much faster and is a little more accurate.

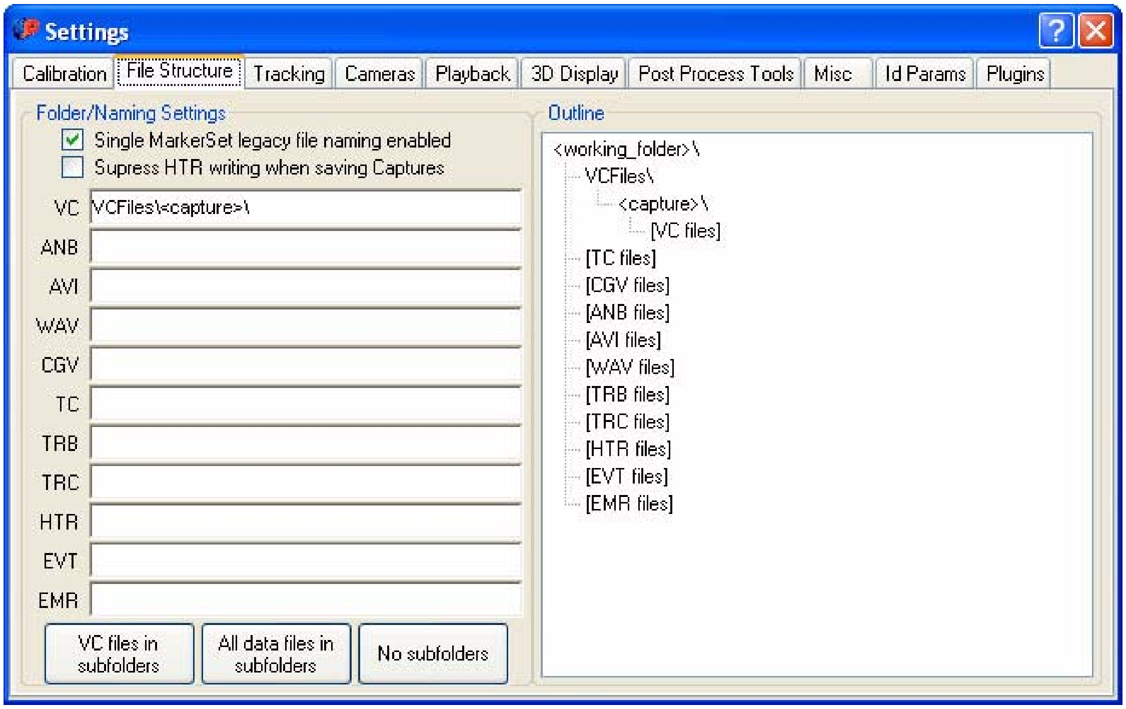
Origin Offset

This allows for translation of the capture volume’s origin from the L-frame’s coordinates. The values are specified in the units that the system is calibrated in (see Calibration Frame). The calibration L-frame may then be positioned anywhere in the motion capture area. This is useful for two possible reasons:

1. All cameras do not see the calibration frame, but you want to use it to position the cameras. In this case, you can move the calibration frame to where it can be seen and enter the Origin Offsets measured from the true origin to the (temporary) location of the calibration frame.
2. You want a different location for an origin for any reason.

Tools > Settings > File Structure Tab

Figure 4-17. File Structure Settings


Settings
Calibration
File Structure
Tracking
Cameras
Playback
3D Display
Post Process Tools
Misc
Id Params
Plugins
Folder/Naming Settings
ANB
AVI
WAV
CGV
TC
TRB
TRC
HTR
EVT
EMR
VC files in subfolders
All data files in subfolders
No subfolders
Outline
<working_folder>\
VCFiles\
<capture>\
[VC files]
[TC files]
[CGV files]
[ANB files]
[AVI files]
[WAV files]
[TRB files]
[TRC files]
[HTR files]
[EVT files]
[EMR files]

☑ Single MarkerSet legacy file naming enabled

☐ Supress HTR writing when saving Captures

VC: VCFiles\<capture>\

Cortex allows a higher level of flexibility in organizing captured data than previous version so Cortex/EVaRT. Captured data can be sorted into subfolders by file type. Additionally files can be named in a legacy naming convention which allows backwards compatibility with older versions of Cortex and other third party applications.

Folder/Naming Settings

This is the region of the settings area allows two types of customization: specifying sub-folders based on data type and enabling the legacy naming conventions.

Single MarkerSet legacy file naming enabled

EVaRT and previous versions of Cortex only recorded one MarkerSet's tracks information. As such, all generated trb files had the name of the capture that was being recorded. All other data types (AVI, ANB, HTR, etc) used "file of the same name" naming conventions for saving and loading the data. Cortex 2is capable of capturing tracks data for multiple MarkerSets, and so has to use different naming conventions for the MarkerSet-specific files (TRB/TRC/HTR/EVT/EMR). Cortex 2 names these files as <trial_name><trial_number>-<MarkerSet_name>.XXX. This results in each MarkerSet's set of files having unique names. To handle this, Cortex 2 introduces the idea of a capture manifest (.cap file), which contains all the needed file names, and doesn't make the same naming assumptions. Some third party applications still depend on the "file of the same name" naming conventions. For this reason Cortex 2 has the **Single MarkerSet legacy file naming enabled** setting. When this setting is enabled AND a capture only contains one MarkerSet, the file names generated for the MarkerSets's data do not contain the MarkerSet name. They are generated as <trial_name><trial_number>.XXX. In this way, they follow the same "file of the same name" conventions that **Cortex** and **EVaRT** used.

Data-Specific sub-folders

These settings are used to specify a different sub-folder for each type of data file. These are all relative paths, with the location of the .cap file being the starting point. The <capture> placeholder can be used to represent the capture name. For example, of you record a capture with trial name "Walk" and trial number "1", the capture name is "Walk1". If the sub-folder specified for the VC files is "VCFiles\<capture>", the VC files for this capture will go in "VCFiles\Walk1".

Note: The paths may not go "above" the working folder. For example ".." is an invalid path.

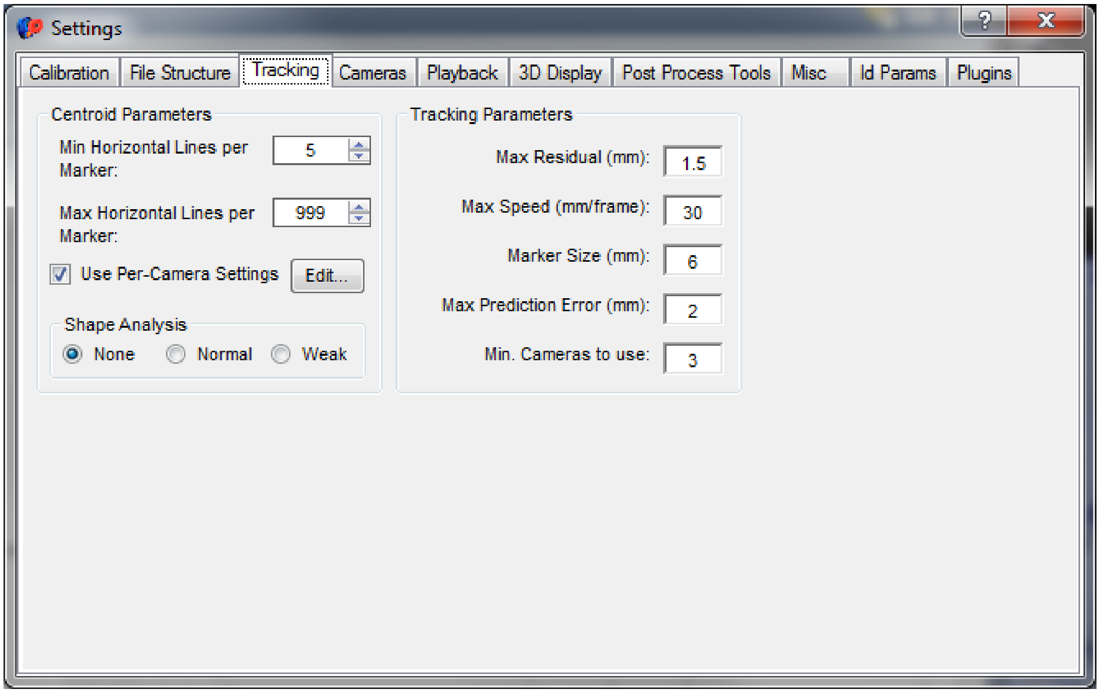
Outline

This section outlines what the folder structure for any captured/saved files will be. It is shown as a directory tree with <working_folder> representing the folder that data is captured into, and <capture> representing the name of the capture.

Tools > Settings > Tracking Tab

The Tracking settings allow modification of the key parameters used when acquiring and tracking data. These settings are all saved in the Setup (.cal) file.

Figure 4-18. Tracking Tab



Centroid Parameters

Min Horizontal Lines per Marker: 5

Max Horizontal Lines per Marker: 999

☑ Use Per-Camera Settings

Shape Analysis

● None ○ Normal ○ Weak

Tracking Parameters

Max Residual (mm): 1.5

Max Speed (mm/frame): 30

Marker Size (mm): 6

Max Prediction Error (mm): 2

Min. Cameras to use: 3

Centroid Parameters

Centroid Parameters control the minimum and maximum number of video lines that are permitted for marker images. If an image size falls outside these limits, no centroid will be calculated for it and it can never become a marker image.

Min. Horizontal Lines per Marker

Sets the minimum number of scan lines a marker must occupy on the camera's sensor for it to qualify as a marker. The value of the parameter entered is dependent on the size of the markers and the distance the camera is away from the markers. A typical value for a 1 inch marker would be 2. For Raptor-4 and Eagle-4 cameras, these values will generally double to 4 lines per marker.

Max Horizontal Lines per Marker

Sets the maximum number of scan lines a marker must occupy on the camera's sensor for it to qualify as a marker. Again, the value of the parameter entered is dependent on the size of the markers and the distance the camera is away from the markers. A typical value for a 1 inch marker would be 50.

Use Per-Camera Settings

This check box allows the Min and Max lines per camera to be set on a per-camera basis. These settings are modified in the **Tools > Settings > Cameras** tab. This can also be accessed by clicking on the **Edit** button.

Shape Analysis

Filters out the centroids of blobs that are not round (e.g. a marker is partially obscured, or two markers have merged).

Tracking Parameters

Tracking parameters are used when correlating the images from several cameras to establish marker coordinates in three dimensions.

Max Residual (mm)

Is the maximum average error when rays from several cameras are combined to establish the coordinates of one marker. If the residual exceeds this amount, it is assumed that these rays are not close enough together to be seeing the same marker. This parameter value should not be less than 4 times, and no greater than 8 times, the average residual value. The average residual value is found in the lower-left corner of the screen when the cameras are running. A typical parameter value is **4 mm.**

Max Target Speed (mm/frame)

Sets a speed limit on the markers. A marker’s track is eliminated when it surpasses this value. When tracking the tip of a golf club or other object with fast moving markers, it is possible that this value will need to be increased. A typical parameter value is **100 mm/frame**. Make it larger if the tracks break into small pieces when tracking fast objects.

Marker Size (mm)

Limits the size of the markers so that higher residual cameras do not see more than one centroid for the same marker. This parameter should be set to the physical size of the markers in use (25.4 millimeters = 1 inch). This parameter will also set the size of the markers that appear on the 3D View.

Max Prediction Error (mm)

Is is used to identify a marker in the next frame. While the software is tracking a marker, it is assumed that it will not deviate by more than this amount along its path. Otherwise the marker will not be identified in the frame. A typical parameter value is **30 mm**. Make it larger if the tracks break into small pieces when tracking fast objects.

Min. Cameras To Use

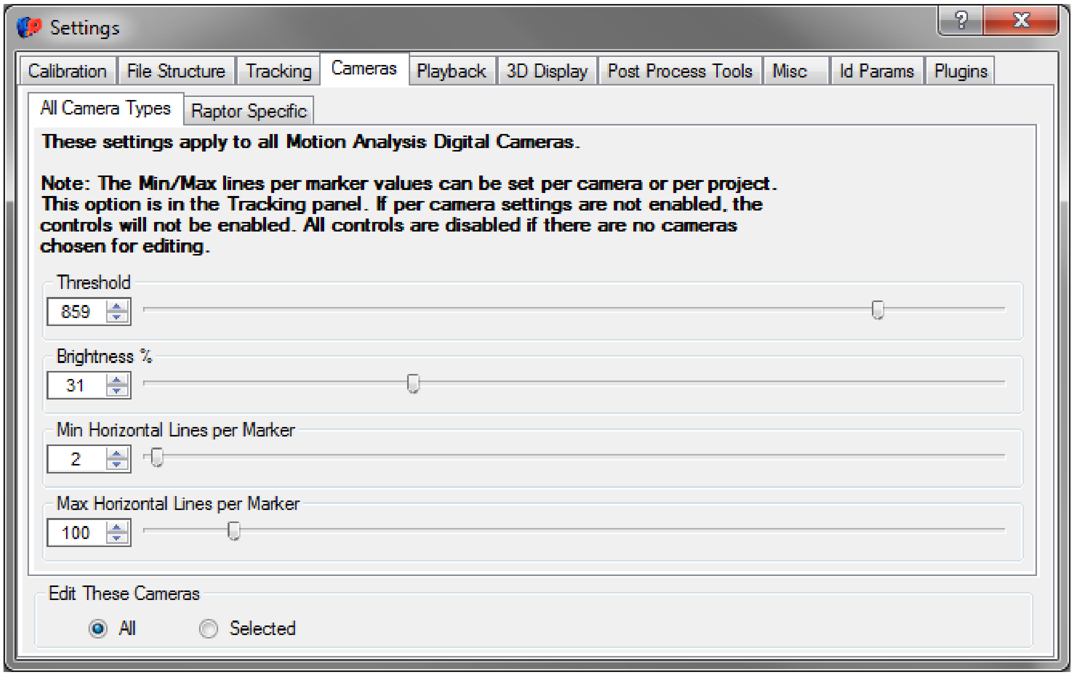
Tells the software what the minimum number of camera’s rays are required to triangulate (track) a marker during a frame. Some users will benefit by setting this value to 3 if spurious data points (ghost markers) are seen in the motion capture sequence. Min Cameras setting of 3 cameras will generally give very good quality data but the setup needs more cameras in place.

Tools > Settings > Cameras Tab

The cameras tab in the settings popup allows cameras settings to be changed. There are two categories of settings: Settings for all cameras types and Raptor-Series specific settings.

All Camera Types

Figure 4-19. Settings > Cameras Tab



These settings apply to all Motion Analysis Digital Cameras.

Note: The Min/Max lines per marker values can be set per camera or per project. This option is in the Tracking panel. If per camera settings are not enabled, the controls will not be enabled. All controls are disabled if there are no cameras chosen for editing.

Threshold: 859

Brightness %: 31

Min Horizontal Lines per Marker: 2

Max Horizontal Lines per Marker: 100

Edit These Cameras: ● All ○ Selected

The settings that are available for all cameras can be changed in the “All Camera Types” sub-tab of the Cameras settings area (pictured above). These settings are: Threshold, Brightness, Min Horizontal Lines per Marker, Max Horizontal Lines per Marker. Each of these settings can be changed for “All” cameras or the “Selected” cameras, based on the setting of the “Edit These Cameras” radio button at the bottom of the Cameras tab.

Threshold

The camera threshold is used to determine what pixels should be included in the edge detection algorithms that take place on the Motion Analysis cameras. Any pixels below this threshold will be considered back ground noise, and be ignored.

Brightness

The brightness setting determines how bright to set the camera ring-light. This is specified as a percentage of the maximum brightness for the ring-light.

Min Horizontal Lines per Marker

This is the minimum number horizontal scan lines required for a group of pixels to be considered a marker, in the camera's 2D view.

Note: This is the per-camera setting and is only used if the "Use Per-Camera Settings" box is checked in the **Settings > Tracking** tab. If these settings are not being used, the slider will be disabled.

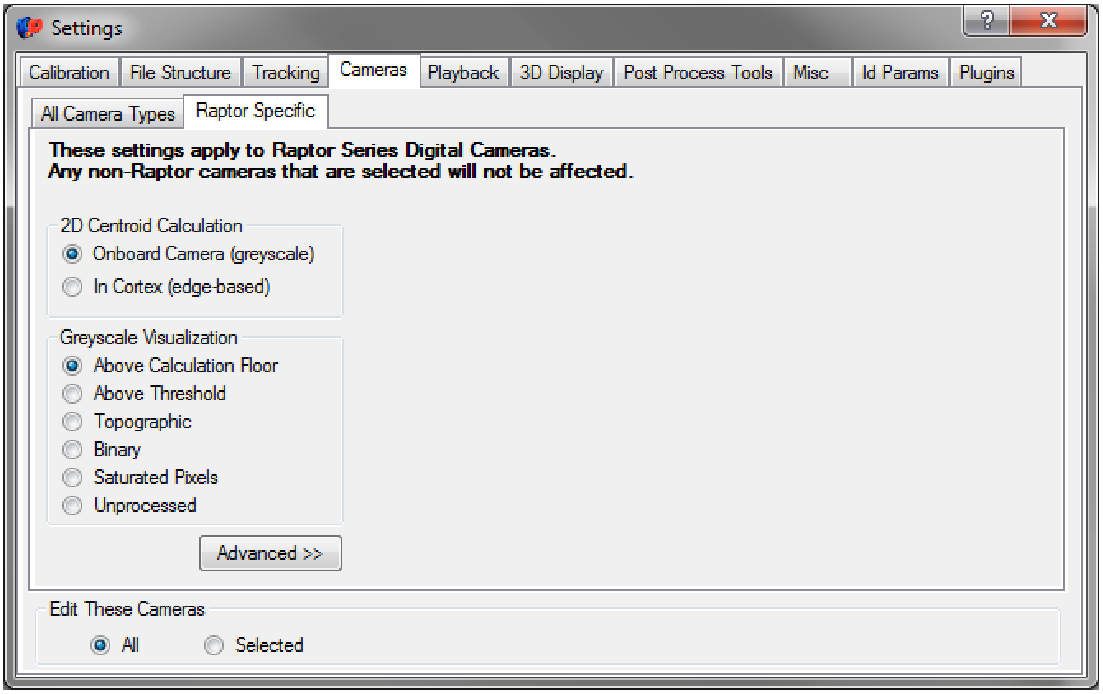
Max Horizontal Lines per Marker

This is the maximum number horizontal scan lines allowed for a group of pixels to be considered a marker, in the camera's 2D view.

Note: This is the per-camera setting and is only used if the "Use Per-Camera Settings" box is checked in the Settings > Tracking tab. If these settings are not being used, the slider will be disabled.

Settings for Raptor Cameras Only

Figure 4-20. Raptor Specific Camera Settings



These settings apply to Raptor Series Digital Cameras.
Any non-Raptor cameras that are selected will not be affected.

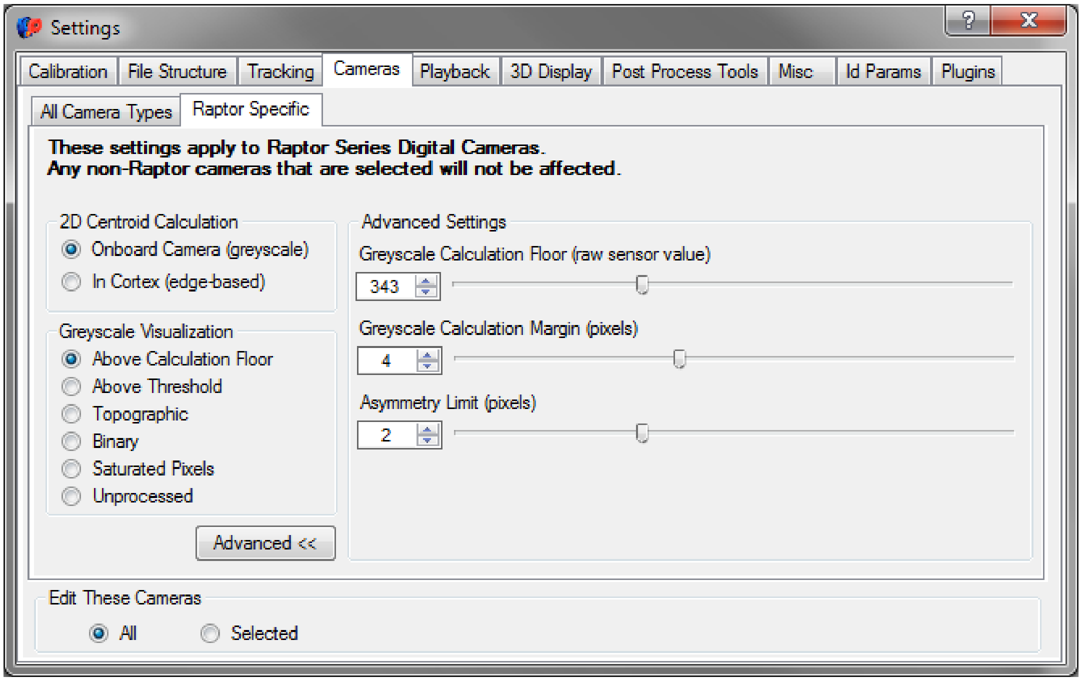
2D Centroid Calculation
● Onboard Camera (greyscale)
○ In Cortex (edge-based)

Greyscale Visualization
● Above Calculation Floor
○ Above Threshold
○ Topographic
○ Binary
○ Saturated Pixels
○ Unprocessed

Edit These Cameras
● All ○ Selected

Settings
?
X
Calibration
File Structure
Tracking
Cameras
Playback
3D Display
Post Process Tools
Misc
Id Params
Plugins
All Camera Types
Raptor Specific
Advanced >>

Figure 4-21. Advanced Raptor Specific Camera Settings



These settings apply to Raptor Series Digital Cameras.
Any non-Raptor cameras that are selected will not be affected.

2D Centroid Calculation
● Onboard Camera (greyscale)
○ In Cortex (edge-based)

Greyscale Visualization
● Above Calculation Floor
○ Above Threshold
○ Topographic
○ Binary
○ Saturated Pixels
○ Unprocessed

Advanced Settings
Greyscale Calculation Floor (raw sensor value): 343
Greyscale Calculation Margin (pixels): 4
Asymmetry Limit (pixels): 2

Edit These Cameras
● All ○ Selected

The settings that are available only for Raptor-Series cameras can be changed in the “Raptor Specific” sub-tab of the Cameras settings area (pictured above). Some of the advanced settings can be displayed/hidden using the “Advanced” button. These settings available for Raptor cameras are: 2D Centroid Calculation, Greyscale Visualization, Greyscale Calculation Floor, Greyscale Calculation Margin, Asymmetry Limit. Each of these settings can be changed for “All” cameras or the “Selected” cameras, based on the setting of the “Edit These Cameras” radio button at the bottom of the Cameras tab.

2D Centroid Calculation

Raptor series cameras have two ways to calculate centroids in the camera’s 2D view. They can be calculated the same as the non-Raptor cameras (i.e. send edge information to **Cortex**) and have them calculated in the Cortex software. In addition, the Raptor cameras have the ability to apply data analysis algorithms to the greyscale camera image, and calculate the centroid on board the camera, sending the final result to Cortex. To have the greyscale images calculated by the camera, select the “Onboard Camera (greyscale)” radio button. To have them send edge data to Cortex, select the “In Cortex (edge-based)” radio button.

Greyscale Visualization

The Raptor series cameras can send their greyscale image to Cortex for visualization. This setting is used to change the visualization method:

- **Above Calculation Floor**—All pixels above the “Greyscale Calculation Floor” setting are rendered in greyscale based on the brightness of the pixel. All other pixels are rendered black.
- **Above Threshold**—All pixels above the camera “Threshold” setting are rendered in greyscale based on the brightness of the pixel. All other pixels are rendered black.
- **Topographic**—Currently undefined.
- **Binary**—All pixels above the “Greyscale Calculation Floor” setting are rendered pure white, while all other pixels are rendered black.
- **Saturated Pixels**—Only fully saturated pixels are rendered.
- **Unprocessed**—The raw greyscale image is rendered.

Greyscale Calculation Floor (raw sensor values)

This is a parameter to the camera’s on-board centroid calculation algorithm. Any pixels below this value will not be used when performing centroid calculations. The units for this setting are raw camera sensor values.

Greyscale Calculation Margin (pixels)

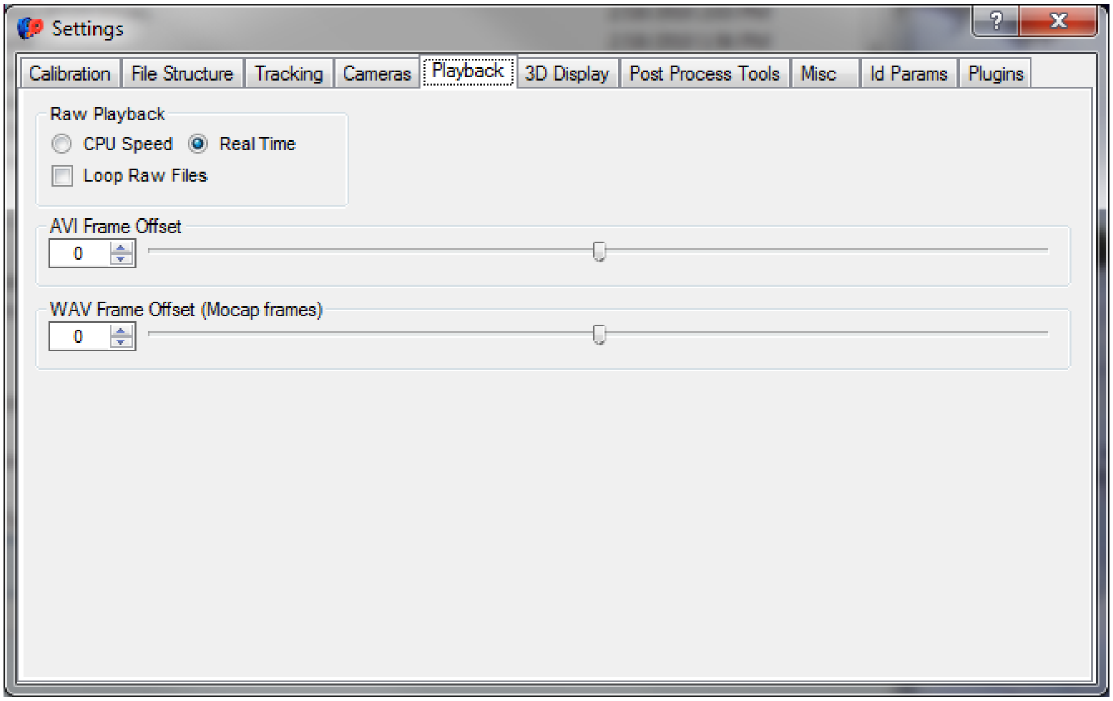
This is a parameter to the camera’s on-board centroid calculation algorithm. The first step in the camera’s image processing algorithm is to find a region of the greyscale image that a centroid exists in. The camera then calculates the centroid within that region. This setting adds an extra margin around the camera’s calculated region of interest, causing more pixels to be included in the calculation.

Asymmetry Limit (pixels)

This is a parameter to the camera’s on-board centroid calculation algorithm. When the camera’s image processing algorithm finds a centroid, it determines the number of horizontal and vertical pixels that the centroid spans. If the difference in these two dimensions is more than this setting, the centroid is discarded.

Tools > Settings > Playback Tab

Figure 4-22. Settings > Playback Tab


Settings
?
X
Calibration
File Structure
Tracking
Cameras
Playback
3D Display
Post Process Tools
Misc
Id Params
Plugins

Raw Playback

○ CPU Speed ● Real Time

☐ Loop Raw Files

AVI Frame Offset

0

WAV Frame Offset (Mocap frames)

0

Raw Playback

These settings modify how raw data playback (VC files, AVI files, etc) is done in Cortex.

CPU Speed

The data is played back as fast as the CPU will allow.

RealTime

The data is played back at the speed it was recorded.

Loop Raw Files

This option is only available when playing back at RealTime speed. When the end of the data is reached, it automatically resets to the beginning and continues playing.

Frame Offsets

When AVI and WAV files are recorded, there is often a frame offset between the AVI/WAV and the VC or tracks data file data. These settings allow that offset to be specified. They apply to both Live Mode and Post Processing.

AVI Frame Offset

If a delay occurs between the reference video (AVI) files and the raw video or tracks files, this adjustable slider is used for correction. Offsets are limited to 100 frames in both the + and – temporal direction. To determine what the offset should be; find a frame of 3D mocap data in the 3D or XYZ view where you see a distinct action, like a golf ball impact or the club being horizontal in the backswing. Adjust the AVI Frame Offset so that the AVI view corresponds to the 3D mocap data view.

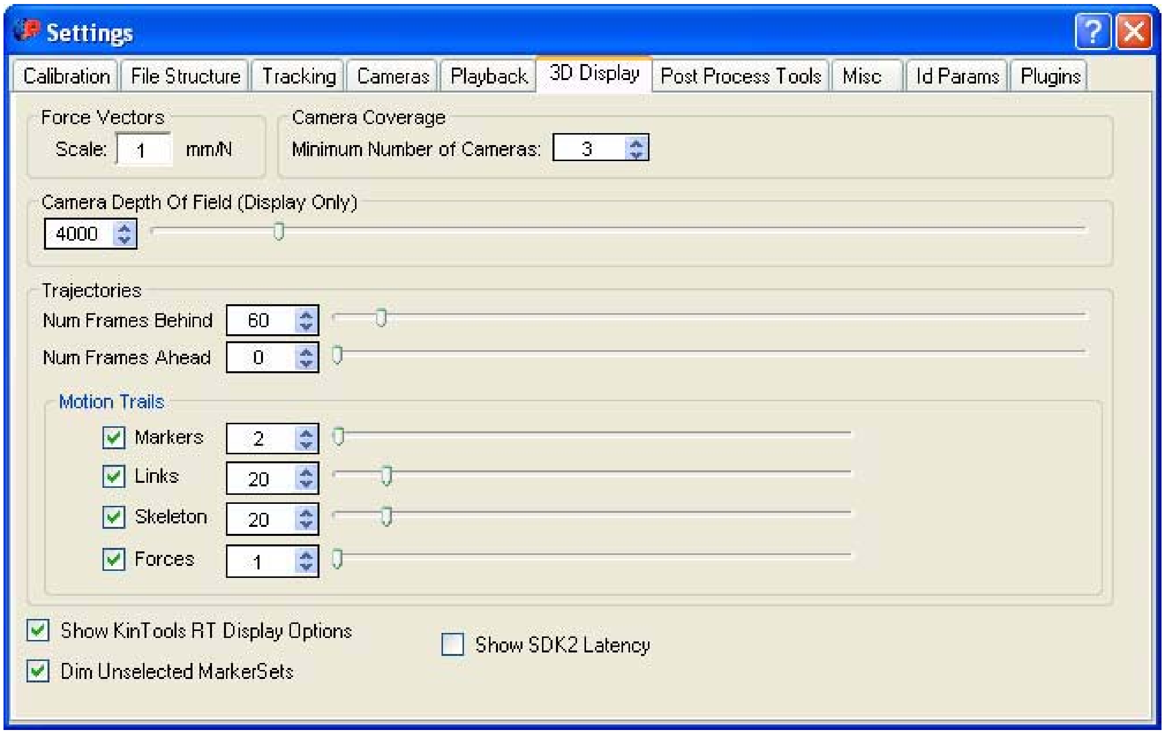
WAV Frame Offset (Mocap frames)

If a delay occurs between the reference audio (WAV) files and the raw video or tracks files, this adjustable slider is used for correction. Offsets are limited to 100 frames in both the + and – temporal direction.

Tools > Settings > 3D Display Tab

These settings affect the rendering of the 3D display.

Figure 4-23. Settings > 3D Display Tab



Force Vectors
Scale: 1 mm/N

Camera Coverage
Minimum Number of Cameras: 3

Camera Depth Of Field (Display Only)
4000

Trajectories
Num Frames Behind 60
Num Frames Ahead 0

Motion Trails
☑ Markers 2
☑ Links 20
☑ Skeleton 20
☑ Forces 1

☑ Show KinTools RT Display Options
☐ Show SDK2 Latency
☑ Dim Unselected MarkerSets

3D Display > Force Vectors

This sets the scale of the force vectors shown in the 3D display. Scale values can range from 0 to ±100 mm/N. A negative scale setting will show the forces below the force plate.

3D Display > Camera Coverage

Sets the number of cameras used for displaying the Camera Coverage region (right-click 3D view, select Show). A small number in this setting results in a large camera coverage display (shown as blocks). A larger number (limited to the number of cameras in the system) will show a smaller coverage volume.

3D Display > Trajectory Length – Number of Frames Behind The Current Frame

When marker trajectories are being displayed (right-click 3D view, select Show), this adjusts the length of the trajectory shown behind the marker's position in the current frame.

3D Display > Trajectory Length – Number of Frames Ahead of The Current Frame

When marker trajectories are being displayed (right-click 3D view, select Show), this adjusts the length of the trajectory shown ahead of the marker's position in the current frame.

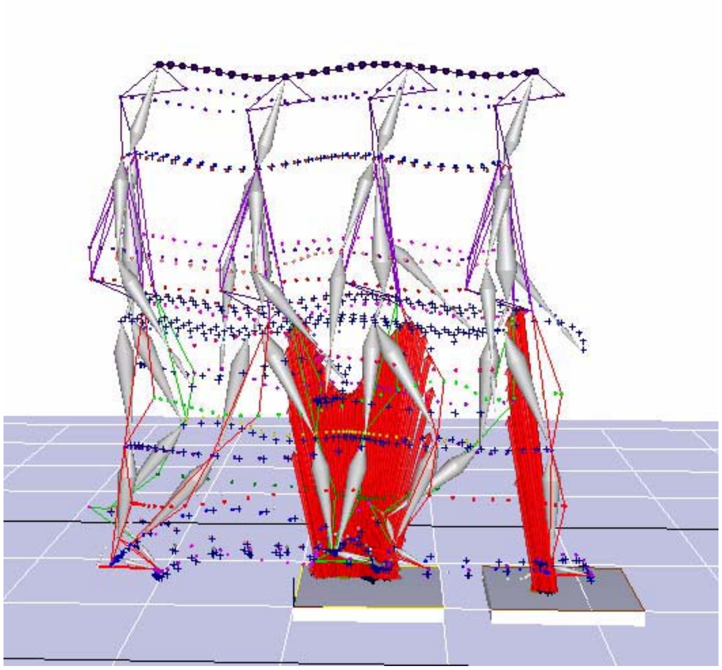
3D Display > Camera Depth of Field

When the camera's field-of-view is being displayed (right-click 3D view, select Show), this option adjusts what depth of field is displayed.

3D Display > Motion Trails

This feature shows the data for markers, links, skeletons, and forces as a trail over a set number of frames. The data frequency can be adjusted to show the information every nth frame.

Figure 4-24. Motion Trails Example



3D Display > Show Kinetics Options

This hides or shows the kinetics options in the 3D Display Show Properties (right-click 3D view, select Show).

3D Display > Dim unselected MarkerSets

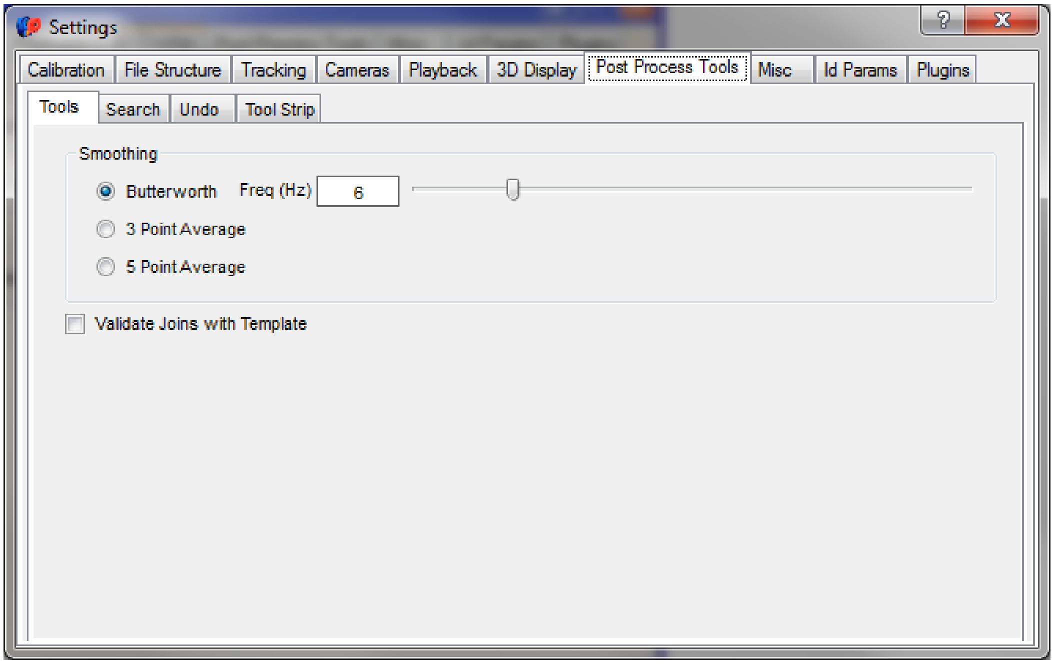
This applies when using multiple MarkerSets. Only one MarkerSet can be selected at a time. When this is checked, then the unselected MarkerSets are drawn partially transparent.

Tools > Settings > Post Process Tools Tab

These settings change how some of the Post Processing tools function, and how the Post Processing Tool Strip looks.

Tools Tab

Figure 4-25. Tools Tab


Settings
?
X
Calibration
File Structure
Tracking
Cameras
Playback
3D Display
Post Process Tools
Misc
Id Params
Plugins
Tools
Search
Undo
Tool Strip

Smoothing

● Butterworth Freq (Hz) 6

○ 3 Point Average

○ 5 Point Average

☐ Validate Joins with Template

Smoothing

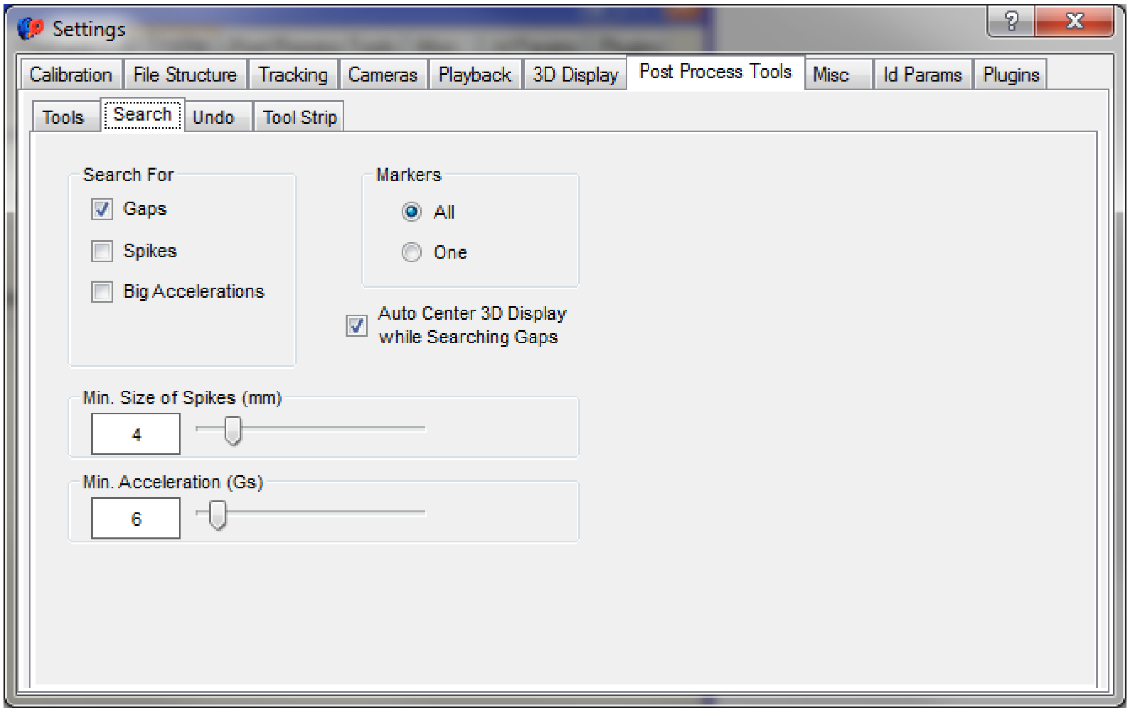
This allows the user to select which automated smoothing filter to use with the “Smooth” tool in Post Processing. The choices are Butterworth, 3-point average and 5-point average.

Validate Joins with Template

When this is enabled, all joins that are done in Post Processing are first checked against the template of the MarkerSet. If the data generated on any frame by a join would fall outside of the template, the join is not performed on that frame. The default setting is not checked.

Search Tab

Figure 4-26. Tools > Settings > Post Process Tools > Search Tab


Settings
?
X
Calibration
File Structure
Tracking
Cameras
Playback
3D Display
Post Process Tools
Misc
Id Params
Plugins
Tools
Search
Undo
Tool Strip

Search For
☑ Gaps
☐ Spikes
☐ Big Accelerations

Markers
● All
○ One

☑ Auto Center 3D Display while Searching Gaps

Min. Size of Spikes (mm): 4

Min. Acceleration (Gs): 6

These settings change the functionality of the “Search” tool in Post Processing.

Search For

This setting indicates what should be searched for. The things that can be searched for are Gaps in the data, Spikes in the data, and “big” accelerations in the data.

Min. Size of Spikes (mm)

This specifies how big a data jump must be to be considered a spike.

Min. Acceleration (Gs)

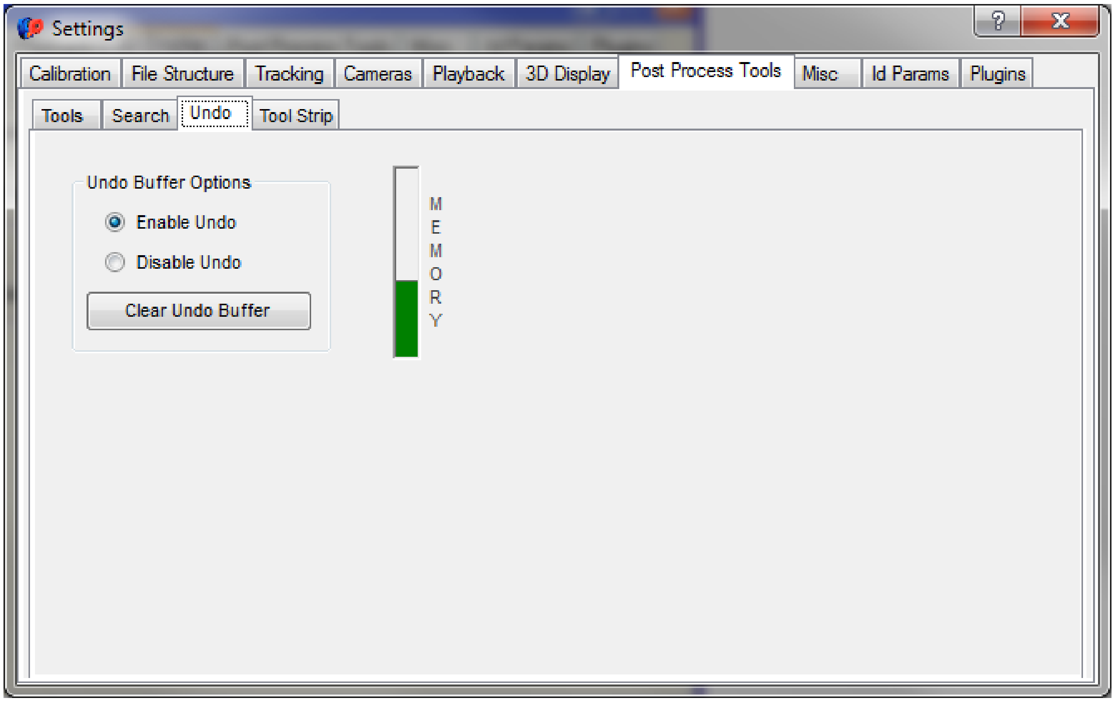
This specifies how big an acceleration must be to be considered “big”.

Markers

This specifies if the search should be performed on one marker or all markers.

Undo Tab

Figure 4-27. Tools > Settings > Post Process Tools > Undo Tab

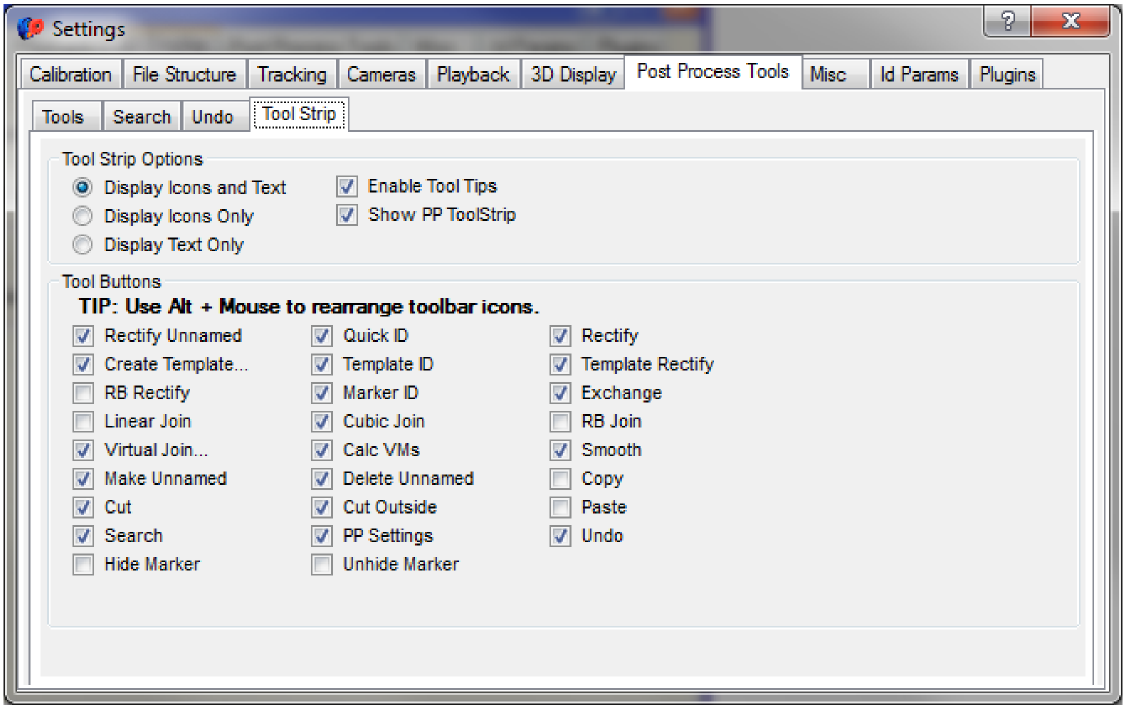

Settings
Calibration
File Structure
Tracking
Cameras
Playback
3D Display
Post Process Tools
Misc
Id Params
Plugins
Tools
Search
Undo
Tool Strip
Undo Buffer Options
Clear Undo Buffer
MEMORY

● Enable Undo
○ Disable Undo

This tab allow the user to turn on and off the Undo function for post-processing data editing. The Undo function can use high levels of memory and this provides the option to turn it off. The Undo Buffer can also be cleared out to lower memory usage by selecting the **Clear Undo Buffer** button.

Tool Strip Tab

Figure 4-28. Tools > Settings > Post Process Tools > Tool Strip Tab



Tool Strip Options

● Display Icons and Text
○ Display Icons Only
○ Display Text Only
☑ Enable Tool Tips
☑ Show PP ToolStrip

Tool Buttons

TIP: Use Alt + Mouse to rearrange toolbar icons.

☑ Rectify Unnamed
☑ Create Template...
☐ RB Rectify
☐ Linear Join
☑ Virtual Join...
☑ Make Unnamed
☑ Cut
☑ Search
☐ Hide Marker
☑ Quick ID
☑ Template ID
☑ Marker ID
☑ Cubic Join
☑ Calc VMs
☑ Delete Unnamed
☑ Cut Outside
☑ PP Settings
☐ Unhide Marker
☑ Rectify
☑ Template Rectify
☑ Exchange
☐ RB Join
☑ Smooth
☐ Copy
☐ Paste
☑ Undo

These Settings adjust the look of the Post Processing Tool Strip. Are stored in a “User Profile”. Different preferences can be saved in different profiles using the Profile Manager (**File > Profile Manager**).

Note: The buttons in the Post Processing Tool Strip can be ordered by click and dragging on the buttons, while holding the Alt key.

Note: This can be opened by right clicking on the Post Processing Tool Strip.

Tool Strip Options

These options change how the buttons are displayed in the Post Processing Tool Strip. The options are Text and Images, Text Only, Images Only. Each button has a tool tip which is displayed when the mouse hovers over it. These can also be enabled/disabled. The whole Tool Strip can also be shown/hidden.

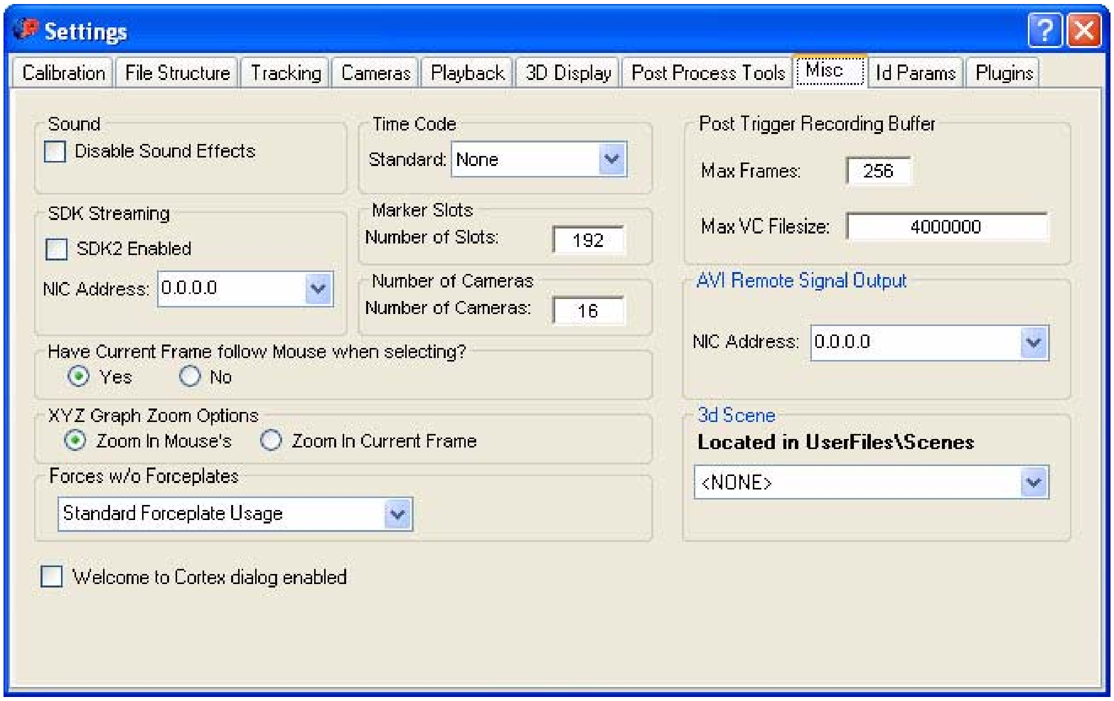
Tool Buttons

This enables/disables specific buttons in the Tool Strip.

Tools > Settings > Misc Tab

This settings area provides a collection of miscellaneous settings the control various portions of the Cortex software.

Figure 4-29. Settings > Misc Tab



Sound
☐ Disable Sound Effects

SDK Streaming
☐ SDK2 Enabled
NIC Address: 0.0.0.0

Time Code
Standard: None

Marker Slots
Number of Slots: 192

Number of Cameras
Number of Cameras: 16

Post Trigger Recording Buffer
Max Frames: 256
Max VC Filesize: 4000000

AVI Remote Signal Output
NIC Address: 0.0.0.0

Have Current Frame follow Mouse when selecting?
● Yes ○ No

XYZ Graph Zoom Options
● Zoom In Mouse's ○ Zoom In Current Frame

Forces w/o Forceplates
Standard Forceplate Usage

3d Scene
Located in UserFiles\Scenes
<NONE>

☐ Welcome to Cortex dialog enabled

Disable Sound Effects

This turns the sound features of **Cortex** on and off. Sounds are generated on data collection events and can be customized by naming files in the **Cortex2\ReleaseXXX** folder. For more information, reference the readme.txt file located in that folder.

Note: Script-generated sounds are not affected by this.

SDK2 Streaming

When enabled, this option streams all motion capture and post process playing data to the NIC address specified. This must be a NIC (Ethernet) address of the Cortex host computer. If there are multiple NIC cards in the host computer, you must indicate which card will be used to stream the SDK2.

Time Code

This function sets the type of Time Code used with the system (if any). The options are SMPTE 29.97 FPS), Film (24 FPS), EBU (25 FPS, same as PAL), System Clock and None (default). To use the SMPTE, Film and EBU options, you need to have a Time Code Reader card installed in the capture computer. With Time Code enabled, each capture will have a CaptureName.tc (time code) file created. Contact **support@motionanalysis.com** for details.

Marker Slots

This function sets the number of marker slots the software will use. Cortex allocates memory based on this number and will variably assign memory according to the number of marker slots used. The maximum number of marker slots that Cortex will allow is 2000. The default number of marker slots is set to 192. More slots require more RAM in your computer to work efficiently.

Note: This setting does not take effect until **Cortex** is quit and re-launched.

Number of Cameras

This function sets the maximum number of cameras the software can use. Cortex allocates memory based on this number. It can be set anywhere between 2 and 250. The default number of cameras is set to 16. More cameras require more RAM in your computer to work efficiently.

Note: This setting does not take effect until Cortex is quit and re-launched.

Have Current Frame follow Mouse when selecting?

When using the mouse to select a range of frames in the XYZ graphs, the current frame will change as the mouse moves, when this is enabled.

XYZ Graph Zoom Options

When zooming in the XYZ graphs, the central point of the zoom can be set to the current frame (red frame line) or the mouse’s position in the XYZ graphs.

Forces w/o Forceplates

This specifies how Cortex should try to calculate ground reaction forces when no forceplate data is present.

Standard Forceplate Usage:

Only calculate ground reaction forces from the forceplate data.

One Foot Off Forceplate:

Use the mass model to calculate the ground forces for the foot that is off the force plate. The foot that is on the plate will have its forces calculated in the standard way.

Calc Without Forceplates:

A standard walking gait is assumed and the mass model is used to calculate the ground reaction forces for both feet.

Welcome to Cortex dialog enabled

Setting this will display the “Welcome to Cortex” dialog whenever Cortex starts. If this is not enabled, the dialog will only be displayed when the on-line content that it displays is updated.

Post Trigger Recording Buffer

This sets the recording session to begin at the specified frames before the end frame of the capture.

Max Frames—256 frames is the default setting. This value can be increased if necessary (uses more RAM).

Max VC File Size—the default max file size is 4 MB per camera. This value can be increased if necessary (uses more RAM).

AVI Remote Signal Output

Currently, only for Windows 7 users—This sets the primary address for the Network Interface Card used to capture the AVI files streaming from **Cortex**.

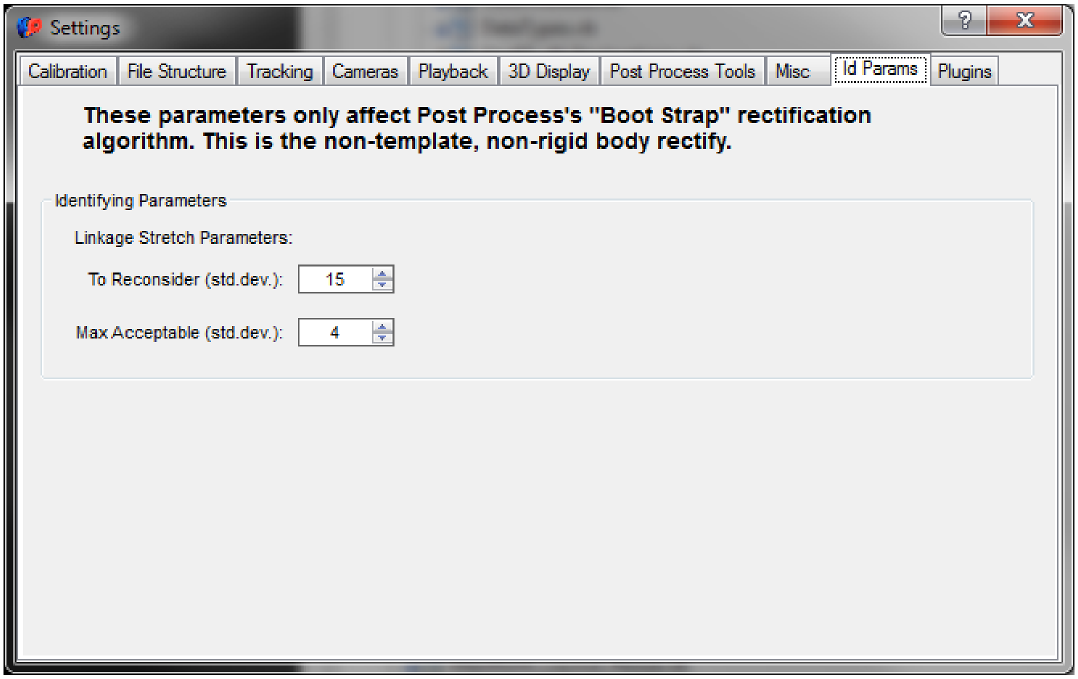
3d Scene

This allows you to select which background scene (.dae file) to use, if available. You must have the **[Collada Models]** license item in your mac_lic.dat file.

Tools > Settings > ID Params Tab

These setting change how the “Rectify” tool in Post Processing works.

Figure 4-30. Settings > ID Params Tab



These parameters only affect Post Process's "Boot Strap" rectification algorithm. This is the non-template, non-rigid body rectify.

Identifying Parameters

Linkage Stretch Parameters:

To Reconsider (std.dev.): 15

Max Acceptable (std.dev.): 4

Linkage Stretch Parameters - To Reconsider (std dev.)

If a link stretches more than the set amount, the path is snipped into two paths where the link stretches too much. This happens if markers come together and pull apart and the identity is not correct when they pull apart. The software may not see it right away, but after a few frames, the linkage for the wrongly named markers get too long and the path is cut. The bigger the number, the more the link is allowed to stretch before it is cut. Smaller means fewer errors, more cuts. Larger means more stretching is allowed before the cuts. It is measured in multiples of the standard deviation of the linkage length to make it accommodate linkages that normally change a lot (head to shoulder) and linkages that do not change much (elbow to wrist).

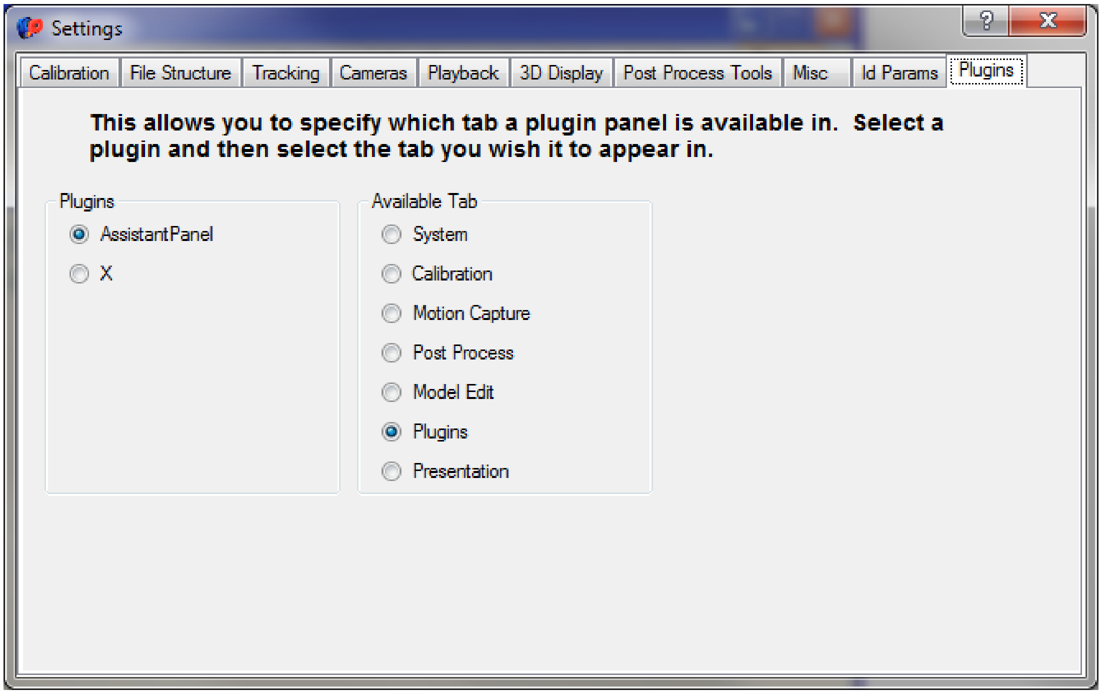
Linkage Stretch Parameters –Max Acceptable (std dev.)

If there is a missing marker and there is an Un-named marker within this distance of known linkages, the Un-named marker is accepted as a Named marker.

Tools > Settings > Plugins Tab

This provides a custom function to set where the Plugins tab will reside within each of the main tabs (System tab, Calibration tab, Motion Capture tab, etc.). The default tab for the X panel is in Plugins.

Figure 4-31. Settings > Plugins Tab



Settings
Calibration
File Structure
Tracking
Cameras
Playback
3D Display
Post Process Tools
Misc
Id Params
Plugins

This allows you to specify which tab a plugin panel is available in. Select a plugin and then select the tab you wish it to appear in.

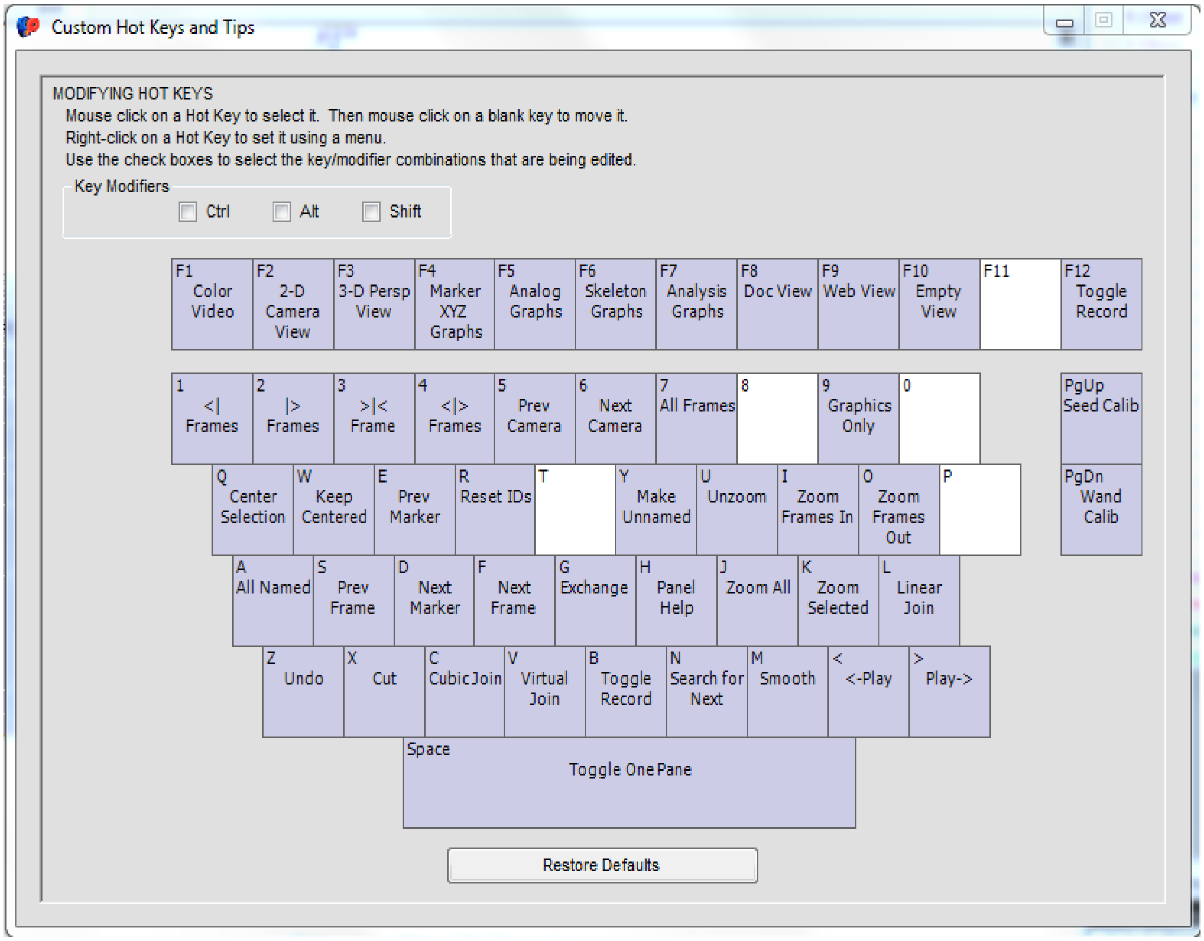
Plugins
- ● AssistantPanel
- ○ X

Available Tab
- ○ System
- ○ Calibration
- ○ Motion Capture
- ○ Post Process
- ○ Model Edit
- ● Plugins
- ○ Presentation

Tools > Hot Keys

Hot Keys are short-cuts which integrate simple to complex procedures into single-key strokes. There are initial default settings and users can also create their own custom Hot Key functions. To change a hot key setup, right-click on the key in the Hot Key layout and select the item you want to do with this hot key. Note that you can pick scripts to run from any hot key. Put the script you want to use in the UserFiles\Skyfiles part of the disk and you will be able to select and run it with a hot key.

Figure 4-32. Default Hot Keys Setup



Custom Hot Keys and Tips

MODIFYING HOT KEYS
Mouse click on a Hot Key to select it. Then mouse click on a blank key to move it.
Right-click on a Hot Key to set it using a menu.
Use the check boxes to select the key/modifier combinations that are being edited.

Key Modifiers
☐ Ctrl ☐ Alt ☐ Shift

F1 Color Video
F2 2-D Camera View
F3 3-D Persp View
F4 Marker XYZ Graphs
F5 Analog Graphs
F6 Skeleton Graphs
F7 Analysis Graphs
F8 Doc View
F9 Web View
F10 Empty View
F11
F12 Toggle Record

1 <| Frames
2 |> Frames
3 >|< Frame
4 <|> Frames
5 Prev Camera
6 Next Camera
7 All Frames
8
9 Graphics Only
0
PgUp Seed Calib

Q Center Selection
W Keep Centered
E Prev Marker
R Reset IDs
T
Y Make Unnamed
U Unzoom
I Zoom Frames In
O Zoom Frames Out
P
PgDn Wand Calib

A All Named
S Prev Frame
D Next Marker
F Next Frame
G Exchange
H Panel Help
J Zoom All
K Zoom Selected
L Linear Join

Z Undo
X Cut
C CubicJoin
V Virtual Join
B Toggle Record
N Search for Next
M Smooth
< <-Play
> Play->

Space Toggle One Pane

Tools > Sky

For Sky information and functions, please refer to Chapter 12, Sky Scripting Interface.

Tools > Time Lines

Shows the time line of the data for each marker, indicating any breaks in the stream of data. More information can be found in “Time Lines” on page 10-26.

Tools > Virtual Marker Definitions

This sets the definition markers that are used to support a particular virtual marker. For complete information regarding Virtual Markers, refer to "Tree View > VMarkers (Virtual Markers)" on page 9-15.

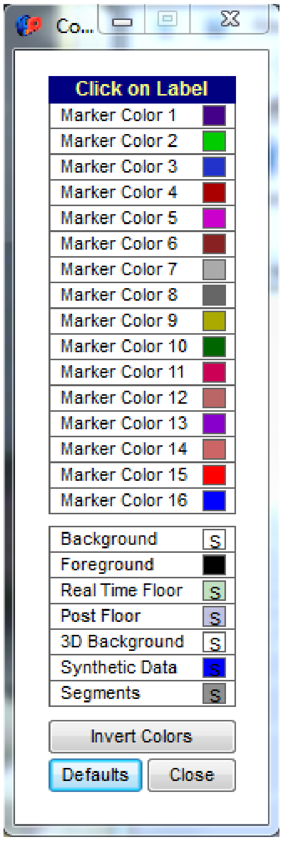
Tools > New Subject

Please refer to "New Subject Button" on page 4-74.

Tools > Colors...

The Colors window allows you to choose RGB colors for the markers, segments, background, foreground, Real-Time floor, and post floor for your capture.

Figure 4-33. Colors Form


Co...
Click on Label
Marker Color 1
Marker Color 2
Marker Color 3
Marker Color 4
Marker Color 5
Marker Color 6
Marker Color 7
Marker Color 8
Marker Color 9
Marker Color 10
Marker Color 11
Marker Color 12
Marker Color 13
Marker Color 14
Marker Color 15
Marker Color 16
Background S
Foreground
Real Time Floor S
Post Floor S
3D Background S
Synthetic Data S
Segments S
Invert Colors
Defaults
Close

To change the color for any item, just click on the colored box and a color palette window opens up. This lets you choose the color blend for that marker. The colors are remembered the next time you launch Cortex.

Tools > Misc

These are functions that are not a part of the normal operation of Cortex or need a place in the menus so that a hot key can be assigned.

Tools > Misc > Replace Loaded Analog Channel Names—Occasionally, there are situations where an incorrect analog channel name can occur. Examples of this can be seen when analysis software (like OrthoTrak) requires specific muscle names for the analysis. In these cases the ability to go back and rename the problem analog channel is required.

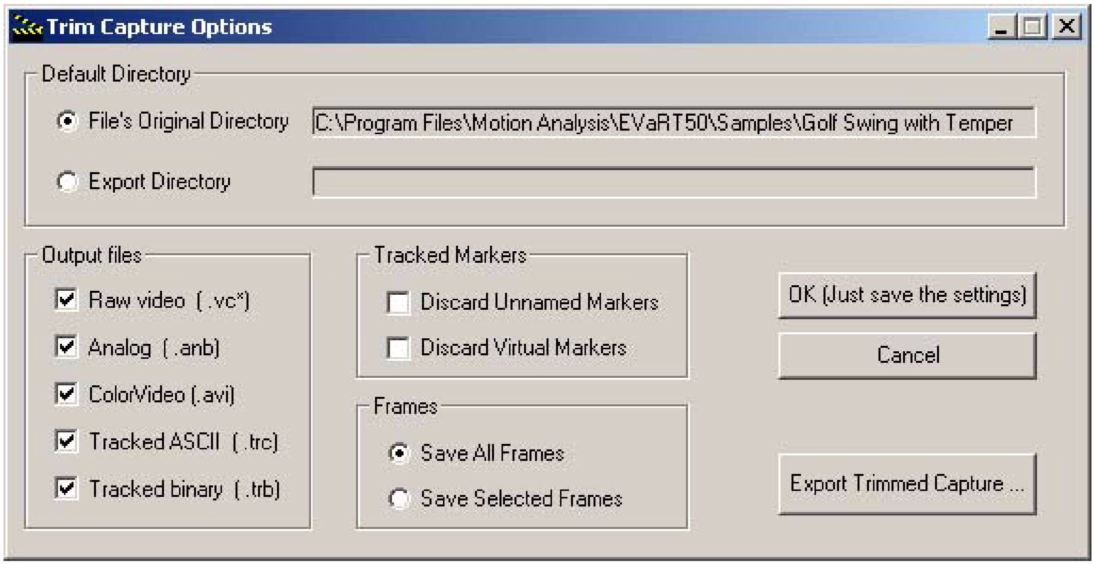
To Rename Analog Channels, follow these steps:

1. Load the Capture (or with legacy data Load a Project file and then select Load a Tracks file).
2. Select **Data Views > Analog Display.**
3. In the existing capture file, go to **System > Analog**, and change the name of the analog channel to the correct name.
4. Go to the Tools menu and select **Misc > Replace Loaded Analog Channel Names**.
5. To see the replaced name, reload the capture file you are working with. This will show the changed name in the Analog display sidebar.

Note: To save this change to the analog file, you must follow the next steps exactly.

6. Select **File > Trim Capture W/Options**.

Figure 4-34. Trim Capture W/Options Interface



Default Directory
● File's Original Directory C:\Program Files\Motion Analysis\EVaRT50\Samples\Golf Swing with Temper
○ Export Directory

Output files
☑ Raw video (.vc*)
☑ Analog (.anb)
☑ ColorVideo (.avi)
☑ Tracked ASCII (.trc)
☑ Tracked binary (.trb)

Tracked Markers
☐ Discard Unnamed Markers
☐ Discard Virtual Markers

Frames
● Save All Frames
○ Save Selected Frames

7. Under the Trim Capture W/Options, choose **Save Selected Frames**. Make sure you have highlighted all the frames that you want by using the middle mouse button to highlight an area in the Post Processing window, or by using the Select All Frames button in the lower right corner.

8. Press the **Export Trimmed Capture** button, and type in the filename you want or keep the current one.
9. If you have more files that need to have the analog channel names replaced, you will need to repeat steps 2 through 9.

Tools > Record—The record function under the Tools menu item starts the recording of a data capture. It is the same function as the Record button found on the **Motion Capture > Output** panel and the F12 function key.

Tools > Misc > Replace Loaded Analog Setup—There have been rare instances where the analog channel setup was not correctly recorded during a capture. This function allows you to Load a capture or an Imported legacy trb/anb file and REPLACE the analog setup with the setup currently loaded and seen in the **System > Analog** panel. This was found to correct some files that were recorded with an incorrect analog setup for unknown reasons. The steps are like the Replace Loaded Analog Channel names function above in that you need to use the **File > Trim Capture W/ Options** to force the analog file to be re-written with the updated channel names and/or other analog setup information.

Tools > Misc > Save Analog Data as...—After importing new or different analog channel data with the **File > Import ANC** menu item, you can save the analog file out again with the new or modified channel or data.

Tools > Misc > Make Slide (Shift+F11)—Defines a place in the menus for the **Shift+F11** hotkey. It is not expected to be used from here to make a new slide.

Tools > Misc > Solver Logs On/Off (Ctrl+Alt+S)—

This enables/disables the generation of log files for the Calcium skeleton solver.

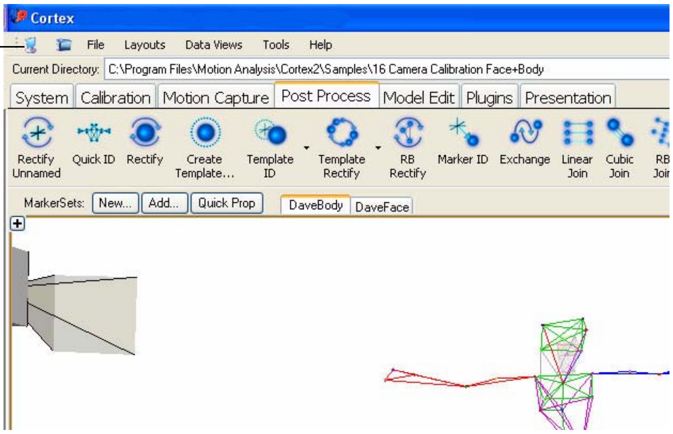
Tools >Misc > Dump Solver Log (Ctrl+Shift+S)—

This prints the solver logs to the status bar. Double-click on the status bar to read them.

Tools > Quick Files

The Quick Files function allows you to easily navigate through frequently used directories, making it easier to address and manage motion capture sessions.

Figure 4-35. Quick Files Icon



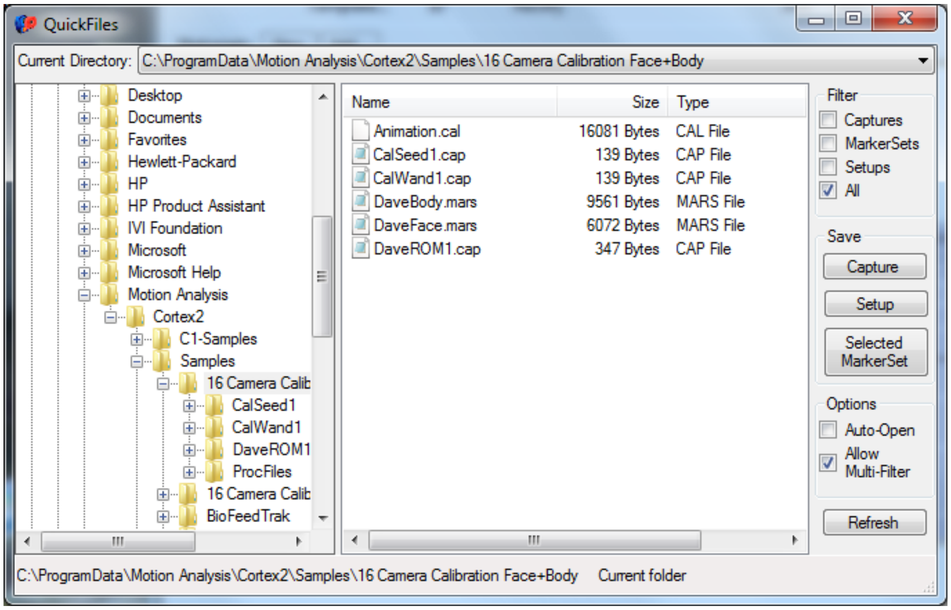
Quick Files Icon

Cortex
File
Layouts
Data Views
Tools
Help
System
Calibration
Motion Capture
Post Process
Model Edit
Plugins
Presentation
Rectify Unnamed
Quick ID
Rectify
Create Template...
Template ID
Template Rectify
RB Rectify
Marker ID
Exchange
Linear Join
Cubic Join
RB Join
MarkerSets:
New...
Add...
Quick Prop
DaveBody
DaveFace

Current Directory: C:\Program Files\Motion Analysis\Cortex2\Samples\16 Camera Calibration Face+Body

The Quick Files window will automatically open upon launch of the **Cortex** software if the Auto-Open check-box is active. You can also launch Quick Files from the icon to the left of the File menu. Note that Quick Files is context sensitive for loading captures: If you have a live mode screen showing in **Cortex**, it performs a Load Capture (Live) function to get ready for the next capture or re-tracking session. If you are in post-processing mode when you load the capture, it will load the capture into post-processing mode.

Figure 4-36. Quick Files Interface



QuickFiles
Desktop
Documents
Favorites
Hewlett-Packard
HP
HP Product Assistant
IVI Foundation
Microsoft
Microsoft Help
Motion Analysis
Cortex2
C1-Samples
Samples
16 Camera Calib
CalSeed1
CalWand1
DaveROM1
ProcFiles
16 Camera Calib
BioFeedTrak
Filter
Save
Capture
Setup
Selected MarkerSet
Options
Refresh

Current Directory: C:\ProgramData\Motion Analysis\Cortex2\Samples\16 Camera Calibration Face+Body

Name	Size	Type
Animation.cal	16081 Bytes	CAL File
CalSeed1.cap	139 Bytes	CAP File
CalWand1.cap	139 Bytes	CAP File
DaveBody.mars	9561 Bytes	MARS File
DaveFace.mars	6072 Bytes	MARS File
DaveROM1.cap	347 Bytes	CAP File

☐ Captures
☐ MarkerSets
☐ Setups
☑ All

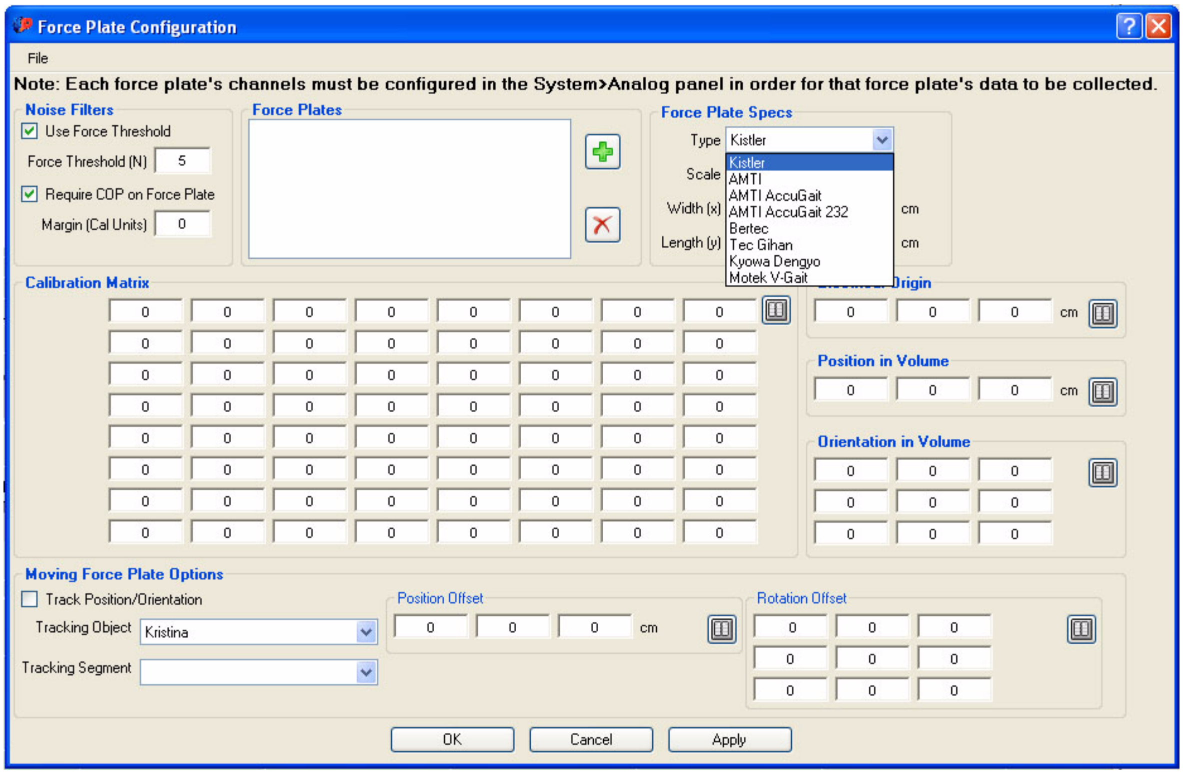
☐ Auto-Open
☑ Allow Multi-Filter

C:\ProgramData\Motion Analysis\Cortex2\Samples\16 Camera Calibration Face+Body Current folder

Tools > Force Plate Configuration...

The Force Plate Configuration Popup is used to setup a force plate configuration. The **System > Analog** panel must still be used to configure of all analog channels, including those used for force plates. The configuration is edited in the popup, and then applied by using the OK or Apply buttons. Once the setup has been applied, it will be used for future data capture sections and be maintained as part of the loaded Setup file. Note, after you apply the configuration, the Setup file is not updated until it is saved.

Figure 4-37. Force Plate Configuration... Interface



Note: Each force plate's channels must be configured in the System>Analog panel in order for that force plate's data to be collected.

Noise Filters

☑ Use Force Threshold

Force Threshold (N): 5

☑ Require COP on Force Plate

Margin (Cal Units): 0

Force Plate Specs

Type: Kistler

Calibration Matrix

0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0
0	0	0	0	0	0	0	0

rigin: 0 0 0 cm

Position in Volume: 0 0 0 cm

Orientation in Volume

0	0	0
0	0	0
0	0	0

Moving Force Plate Options

☐ Track Position/Orientation

Tracking Object: Kristina

Tracking Segment:

Position Offset: 0 0 0 cm

Rotation Offset

0	0	0
0	0	0
0	0	0

(Force Plate Configuration) File > Menu

Import forcepla.cal… and Export forcepla.cal…

Reads or writes legacy forcepla.cal files. When importing, the forcepla.cal file's contents are loaded into the form, and must be applied (via the OK or Apply buttons) before they will take effect. When exporting, the contents of the form are exported, even if they have not been applied. Not all data in a force plate configuration can be represented using a forcepla.cal file, so any unsupported data is excluded. Forcepla.cal files are still maintained because they are used by the OrthoTrak software. Force plate configuration is now stored in your setup file, so unless you need it for other reasons (like OrthoTrak compatibility), you do not need to save the forcepla.cal as a separate file.

(Force Plate Configuration) File > Refresh

Refresh the form to match the configuration which is currently loaded. This is useful if a new Setup file, which uses a different configuration, has been loaded while the form is open.

Force Plates List

This list displays the force plates that have been defined for the current configuration, allows addition/removal of plates, and displays the configuration status of each plate. To add a plate, simply click on the green **+** button. To remove a plate, click on the red **X** button. A plate can be selected by clicking in the list. The input controls will be changed to reflect the selected force plate. No changes are made to the loaded configuration until they are saved or applied. The force plate list will display the status of a plate, compared to the configuration that was loaded into the form. If the force plate has a (+) before its name, then it is a newly added plate. A (–) indicates that the plate is being removed. A (*) indicates that the plate information has been modified and needs to be saved.

Force Plate Specs

These input controls allow some general information about the force plate to be specified. The things specified are: the type of force plate, the scale factor applied to the force plate, and the size of the force plate. The scale factor and size values should be the same as those in the forcepla.cal file.

Force Plate Calibration

These inputs allow you to specify the force plate calibration information. This information is the same as that in the forcepla.cal file, and should be obtained from the manufacturer. Clicking on the “book” icon next to a matrix input region will allow the information to be input using a notepad-style control. This is useful for copy and pasting from an existing document. Entries are delimited by spaces and new lines.

There is also a button in this panel for running the Kyowa-Dengyo calibration procedure. If there are no pending force plate changes, and all force plates are of type Kyowa-Dengyo, then a button will be present to run the Kyowa-Dengyo calibration. The calibration results will be loaded into the force plate configuration form. The results can be treated as any normal calibration edit would be (applied, saved, cancelled).

Force Plate Position and Orientation

These inputs allow you to specify the force plate position and orientation in the lab. For moving force plates, this information is not used since the plate position is determined by marker tracking.

Moving Force Plate Options

In this area, a force plate can be specified as a moving force plate, and the means for tracking it can be defined. To track a force plate, it needs to have a skeleton segment (SkB or SIMM Calcium) defined, which represents the force plate’s position and orientation. This will generally involve placing a unique marker configuration on the force plate, so that the segment can be uniquely identified. A configuration similar to the calibration L-Frame should work well. Additionally, a positional and rotational offset can be applied to the segment position and orientation to get the force plate's final tracked position. To specify that the force plate is to be tracked, check the "Track Position/Orientation" check box and select a tracking object and tracking segment from the pull down menus. Enter a translation vector in the "Position Offset" fields, and a rotation matrix in the "Rotation Offset" fields.

Note: It is not necessary to have a segment for every force plate, as long as they remain in a fixed configuration. In this case, a single segment can be created, used to track all force plates, and each force plate can use different orientation parameters to offset itself from the segment.

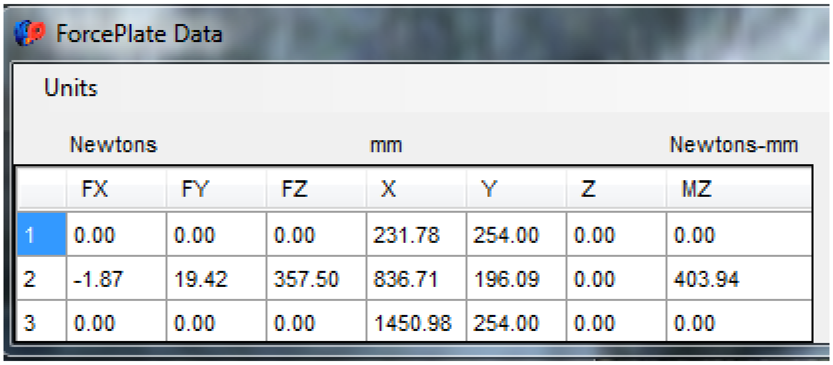
Buttons

- The OK button will apply the force plate configuration to the currently loaded Setup and close the form.
- The Cancel button will close the form without applying the configuration.
- The Apply button will apply the force plate configuration to the currently loaded Setup and leave the form open.

Tools > Force Plate Forces

Selecting this feature will display the force plate measurements in numerical values. This works when you are live and connected to the cameras, or when you are simulating Real Time from VC files and you are Post Processing mode. You can change the units to one of the following: Force-Newtons (default), Force: Kilograms-Force and Force: Pound-Force.

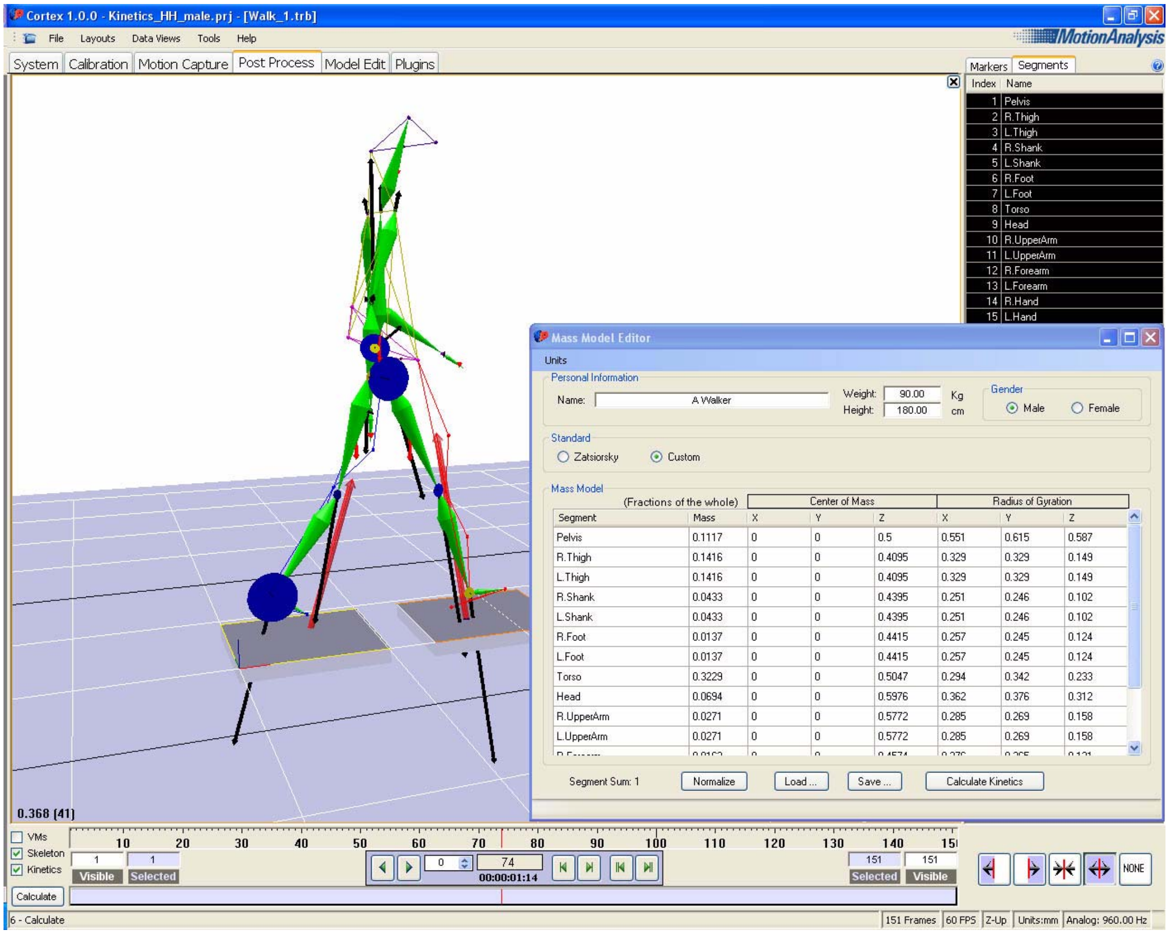
Figure 4-38. Force Plate Forces



	Newtons			mm			Newtons-mm
	FX	FY	FZ	X	Y	Z	MZ
1	0.00	0.00	0.00	231.78	254.00	0.00	0.00
2	-1.87	19.42	357.50	836.71	196.09	0.00	403.94
3	0.00	0.00	0.00	1450.98	254.00	0.00	0.00

Tools > Mass Model Editor

Figure 4-39. Mass Model Editor


Cortex 1.0.0 - Kinetics_HH_male.prj - [Walk_1.trb]
File
Layouts
Data Views
Tools
Help
MotionAnalysis
System
Calibration
Motion Capture
Post Process
Model Edit
Plugins
Markers
Segments
0.368 (41)
VMs
Skeleton
Kinetics
Visible
Selected
Calculate
00:00:01:14
NONE
6 - Calculate
151 Frames
60 FPS
Z-Up
Units:mm
Analog: 960.00 Hz
Mass Model Editor
Units

Index	Name
1	Pelvis
2	R.Thigh
3	L.Thigh
4	R.Shank
5	L.Shank
6	R.Foot
7	L.Foot
8	Torso
9	Head
10	R.UpperArm
11	L.UpperArm
12	R.Forearm
13	L.Forearm
14	R.Hand
15	L.Hand

Personal Information

Name: A Walker

Weight: 90.00 Kg

Height: 180.00 cm

Gender: ● Male ○ Female

Standard: ○ Zatsiorsky ● Custom

Mass Model

(Fractions of the whole)		Center of Mass			Radius of Gyration		
Segment	Mass	X	Y	Z	X	Y	Z
Pelvis	0.1117	0	0	0.5	0.551	0.615	0.587
R.Thigh	0.1416	0	0	0.4095	0.329	0.329	0.149
L.Thigh	0.1416	0	0	0.4095	0.329	0.329	0.149
R.Shank	0.0433	0	0	0.4395	0.251	0.246	0.102
L.Shank	0.0433	0	0	0.4395	0.251	0.246	0.102
R.Foot	0.0137	0	0	0.4415	0.257	0.245	0.124
L.Foot	0.0137	0	0	0.4415	0.257	0.245	0.124
Torso	0.3229	0	0	0.5047	0.294	0.342	0.233
Head	0.0694	0	0	0.5976	0.362	0.376	0.312
R.UpperArm	0.0271	0	0	0.5772	0.285	0.269	0.158
L.UpperArm	0.0271	0	0	0.5772	0.285	0.269	0.158

Segment Sum: 1

Normalize
Load ...
Save ...
Calculate Kinetics

The Mass Model Editor shows, in tabular format, how the mass is distributed throughout the segments of the current skeleton model.

For more information, refer to the *KinTools RT User's Manual*.

Tools > BioFeedTrak Event Editor

The Event Editor Dialog is used to edit Event and Cycle definitions. The Event Editor form consists of two main components, the Events Area and the Scripts Area. The Events Area is used for adding/removing/editing Event and Cycle definitions. The Scripts Area is used to view the status of the scripts that are used by the Events.

Events Area

The left portion of this area contains tabs for each type of Event/Cycle. There are two general categories of Event: User-Defined Events and Built-In Events. There may be multiple sub-types of Built-In Events, i.e. Gait Events. Built-In Events are discovered using algorithms that are embedded in the Cortex software. User-Defined Events are Events which are discovered using algorithms provided by a user, via Sky scripting. There is a button next to the tabs for adding/removing User-Defined Events and Cycles.

The right portion of the Events Area is for editing the Events and Cycles. Each type of Event/Cycle has different properties that can be edited.

User-Defined Event Properties

Name—The name of the Event. All Events must have unique names.

Description—A description of what the Event represents.

Color—The color in which the Event is illustrated, which shows up on the presentation graphs.

Event Script—The Sky script that contains the functionality for this Event. An Event script is optional if all the necessary functions are contained in a graph script.

Enabled For Live—Enables/Disables the Event in Live Mode.

Enabled For Post—Enables/Disables the Event in Post Processing.

Built-In Event Properties (Gait)*

Name—The name of the Event. This is not editable.

Description—A description of what the event is detecting. This is not editable.

Color—The color in which the Event is illustrated, which shows up on the presentation graphs.

Enabled For Live—Enables/Disables the Event in Live Mode.

Enabled For Post—Enables/Disables the Event in Post Processing.

Cycle Properties

Name—The name of the Cycle. All Cycles must have unique names.

Description—A description of what the Cycle represents.

Color—The color in which the Event is illustrated, which shows up on the presentation graphs.

Start Event—The Event that triggers the beginning of the Cycle.

End Event—The Event that triggers the end of the Cycle. This can be the same as the Start Event.

More on Event Scripts

The Event script specifies what feedback will be provided for an Event. The Sky functions that are used for setting the Event flags are swEvents_SetUserEventOnFrame and swEvents_GetUserEventOnFrame. For more information on writing Event scripts, see the BioFeedTrak tutorial in **Help > Tutorials**.

Scripts Area

The lower portion of this area contains a grid that lists all scripts, when they were compiled, and any runtime-errors that were encountered while executing the script. The scripts must be compiled, in order for the Event detection engine to make use of them. This is done in advance, so that run-time resources are not consumed by the task. There is a check box to Auto-Compile the scripts when a new Setup is loaded. If the script is modified while Cortex is running, it must be re-compiled for the Events engine, from this dialog. If the script fails to execute at run-time, a run-time error will be set in the grid, and the script will not be executed until the error is cleared. This is done by re-compiling the script, presumably after the script has been fixed to avoid the run-time error.

*Gait Events Note

To calculate the automatic gait events, it is required that **Cortex** can find the pelvis and the feet. This is done using the following assumptions:

1. The markerset has only one global segment and it is at the pelvis. If there is more than one global segment, it will use the last one in the list which may cause problems if the foot segment is parented to global and listed below the pelvis segment. The name of the pelvis segment does not matter but what matters is that the origin be located near the L5/S1 joint for the automated gait event algorithm to work properly. The pelvis and feet may be either Skeleton Builder or Calcium segments.
2. The foot segments follow this naming conventions.

   Left foot:
   We look for LFOOT, L.FOOT, LFOOTPAD, or L.FOOTPAD.
   The last one found is used. Upper or lower case letters may be used.

   Right foot:
   Without regard to case, we look for RFOOT, R.FOOT, RFOOTPAD, or R.FOOTPAD.
   The last one found is used.

If a FOOTPAD segment is present, it takes precedence over the other foot bones. The FOOTPAD segment would be a segment touching the floor.

Graphing Script Note

The graphing script may contain event settings which will cause problems in some setups. In general it is a good idea to use the graph scripts to set and clear "Event Frames" with good reason.

The following issues may help distinguish between their uses:

1. Graphs scripts get updated every time the graph is displayed in real time or in post processing. This could be a problem if the user goes to edit the event frames in Post Processing. When the user goes back to the graph view, these edits would be wiped out.
2. Event scripts can be turned on and off with the Events check box on the realtime dashboard, while graph scripts run ONLY IF the graphs panel is visible.
3. Graph scripts get executed first, then event scripts. If something is calculated in a graphs script, the calculated variable(s) are available in the event script, but ONLY IF THE GRAPH is showing. See the example below for swGetData_UserGraphs(iGraph).

The below Cortex-Sky documentation shows how to get data from a graphs script and use it in the event script. This is a good way to develop the event scripts.

```
----------------
swGetData_UserGraphs(iGraph)
Gets the current data in the specified graph
Return Value
Double: The current value in the graph
Input Values
NONE
See Also
swGetData_XXX functions
Example


Sub FeedbackFromGraph
' Get the graph value from the second graph
Dim Value as Double = swGetData_UserGraphs(1) ' zero
based index
' Use the value as the volume control
swSoundPlay("440", ,Value)
   End Sub
```

Tools > BioFeedTrak Event Timeline

The BioFeedTrak Event Time Line Dialog is used to display and edit which frames an event occurs on. These can be automatically detected and manually set/changed.

Form Controls

Event Type, Event Name, Event Frame

Displays the information about the currently selected event. The Event Frame up-down can be used to change the frame number for the event.

Snap To

Move the selected event to the current frame.

Auto-Discover All

Clears all event frames and does an automatic discovery over all frames, for all events.

Clear All

Clears all event frames.

+Buttons

These buttons add the corresponding event on the current frame.

Editor…

Opens the Event Editor.

Refresh

Forces the popup to refresh itself.

Time Line Visualization

The timeline displays events as vertical lines and cycles as a transparent fill between events. The selected event is rendered extra-thick.

Mouse Controls

Controlling the Current Frame

Left Click to select, Left click and drag to scrub.

Selecting an Event

Ctrl+Left Click is used to select an event.

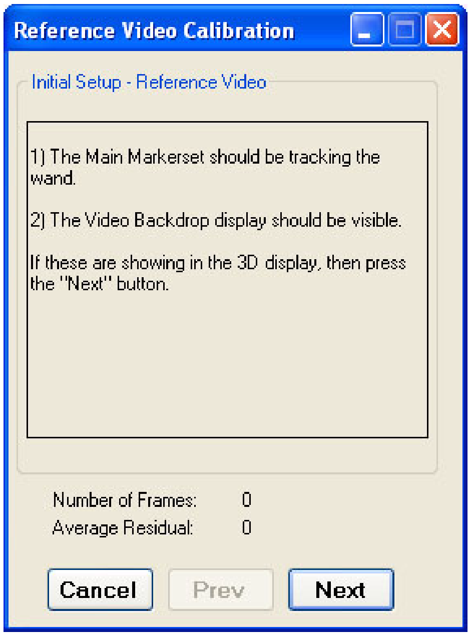
Modifying Event Frames

To move an event, select it, continue holding Ctrl+Left Click and drag it. A frame can also be moved one frame at a time by selecting it then Ctrl+Shift+Left Click on either side of it.

Tools > Reference Video Calibration Wizard...

This function sets the 3D Display (including marker cloud, skeleton, skins, forces, etc.) to match the orientation of the Reference Video. This is useful when overlaying the two perspectives. The interface provides instruction as you work your way through the process.

Figure 4-40. Tools > Reference Video Calibration Wizard



1) The Main Markerset should be tracking the wand.

2) The Video Backdrop display should be visible.

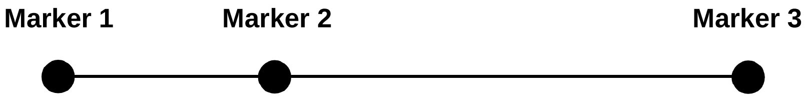
If these are showing in the 3D display, then press the "Next" button.

Number of Frames: 0
Average Residual: 0

Note: You must start by loading the 3-marker wand capture file. This can be done by creating a wand capture with a template or selecting it from the **Motion Capture > Objects > Select Markerset > System** tab.

Note: The wand template must be set so that marker 1 is on the end, marker 2 is closest to marker 1, and marker 3 is on the opposite end of marker 1 (reference Figure 4-41).

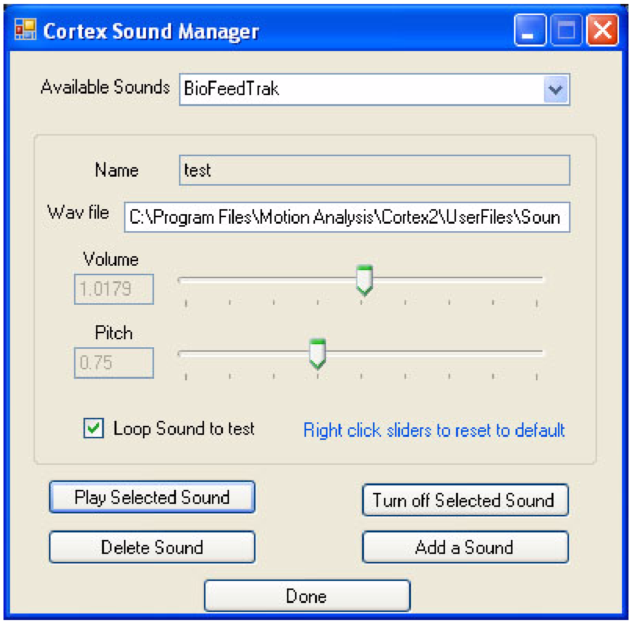
Figure 4-41. Wand Marker Order for Setting Up Template



Tools > Sound Manager

The Sound Manager is used to configure the sound files associated with BioFeedTrak scripting.

Figure 4-42. Sound Manager Interface


Cortex Sound Manager
Play Selected Sound
Turn off Selected Sound
Delete Sound
Add a Sound
Done

Available Sounds: BioFeedTrak

Name: test

Wav file: C:\Program Files\Motion Analysis\Cortex2\UserFiles\Soun

Volume: 1.0179

Pitch: 0.75

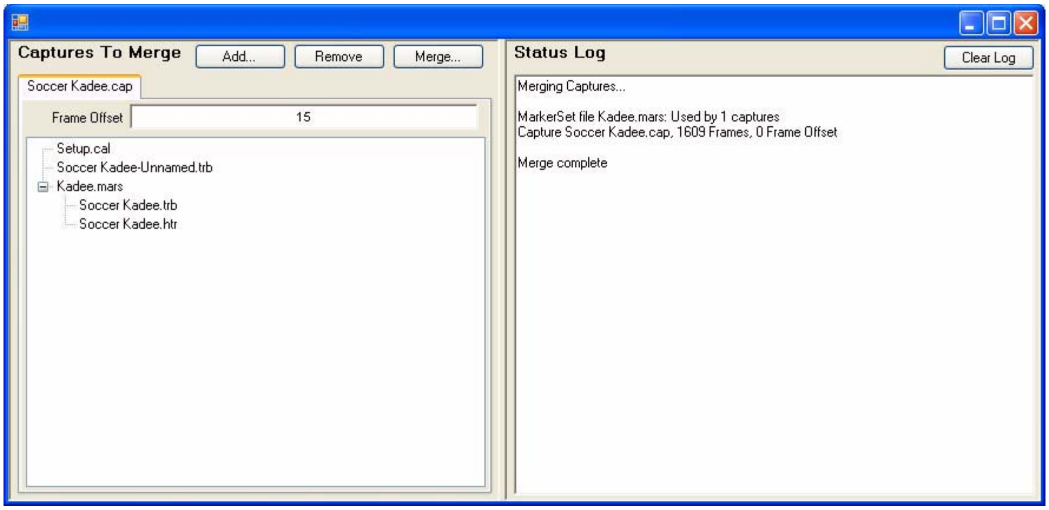
☑ Loop Sound to test

Right click sliders to reset to default

Tools > Merge Captures

This function is used to merge multiple capture files into one. This is useful for combining both prop captures and multiple subject captures. There is also a frame offset function to adjust the timing of the start/end of the various captures.

Figure 4-43. Merge Captures


Captures To Merge
Add...
Remove
Merge...
Status Log
Clear Log
Soccer Kadee.cap

Frame Offset: 15

- Setup.cal
- Soccer Kadee-Unnamed.trb
- Kadee.mars
  - Soccer Kadee.trb
  - Soccer Kadee.htr

```
Merging Captures...

MarkerSet file Kadee.mars: Used by 1 captures
Capture Soccer Kadee.cap, 1609 Frames, 0 Frame Offset

Merge complete
```

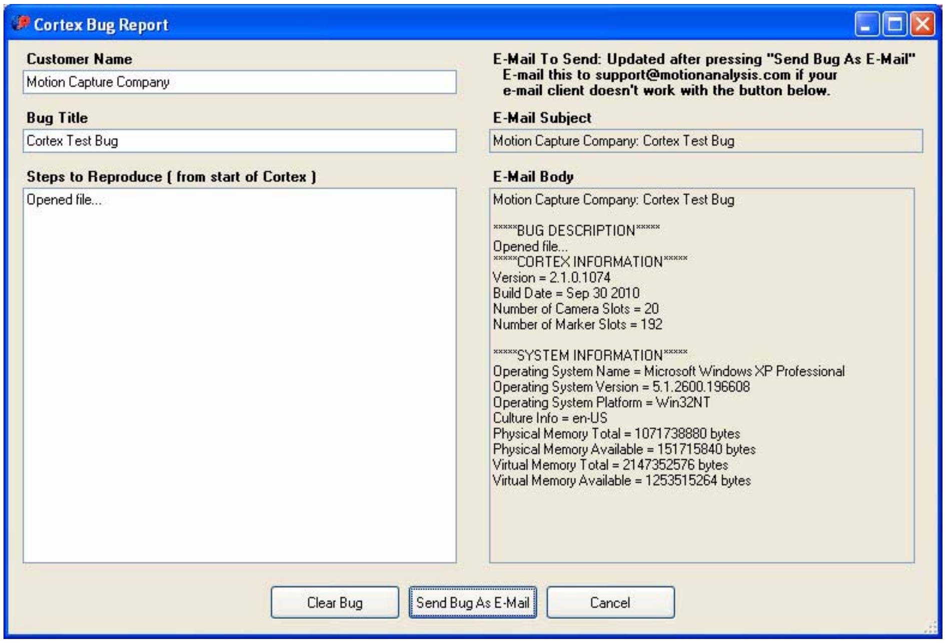
Tools > Replace Tracks Data...

This replaces the currently loaded tacks data with data from another cap file.

Tools > Report a Bug...

If you encounter a bug in the software, Motion Analysis has provided a quick and easy way to enter the information and email it to the software development group.

Figure 4-44. Bug Report Interface



Customer Name
Motion Capture Company

Bug Title
Cortex Test Bug

Steps to Reproduce (from start of Cortex)
Opened file...

E-Mail To Send: Updated after pressing "Send Bug As E-Mail"
E-mail this to support@motionanalysis.com if your e-mail client doesn't work with the button below.

E-Mail Subject
Motion Capture Company: Cortex Test Bug

E-Mail Body

```
Motion Capture Company: Cortex Test Bug

*****BUG DESCRIPTION*****
Opened file...
*****CORTEX INFORMATION*****
Version = 2.1.0.1074
Build Date = Sep 30 2010
Number of Camera Slots = 20
Number of Marker Slots = 192

*****SYSTEM INFORMATION*****
Operating System Name = Microsoft Windows XP Professional
Operating System Version = 5.1.2600.196608
Operating System Platform = Win32NT
Culture Info = en-US
Physical Memory Total = 1071738880 bytes
Physical Memory Available = 151715840 bytes
Virtual Memory Total = 2147352576 bytes
Virtual Memory Available = 1253515264 bytes
```

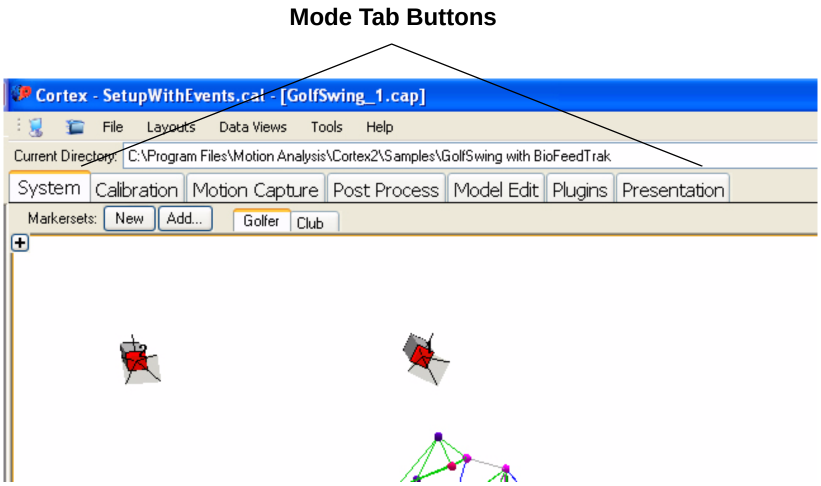
Help Menu

The Help menu provides information about the software, along with shortcuts, interface panel information, a searchable on-line manual, and access to the video tutorials.

Mode Tab Buttons

These buttons are arranged to guide you through a motion capture session in a phase-oriented order. Refer to Figure 4-45. The first three mode buttons (System, Calibration, and Motion Capture) activate Real-Time mode and present you the necessary tools to successfully capture motion data.

Figure 4-45. Mode Tab Buttons


Mode Tab Buttons
Cortex - SetupWithEvents.cal - [GolfSwing_1.cap]
File
Layouts
Data Views
Tools
Help
System
Calibration
Motion Capture
Post Process
Model Edit
Plugins
Presentation
Markersets:
New
Add...
Golfer
Club

Current Directory: C:\Program Files\Motion Analysis\Cortex2\Samples\GolfSwing with BioFeedTrak

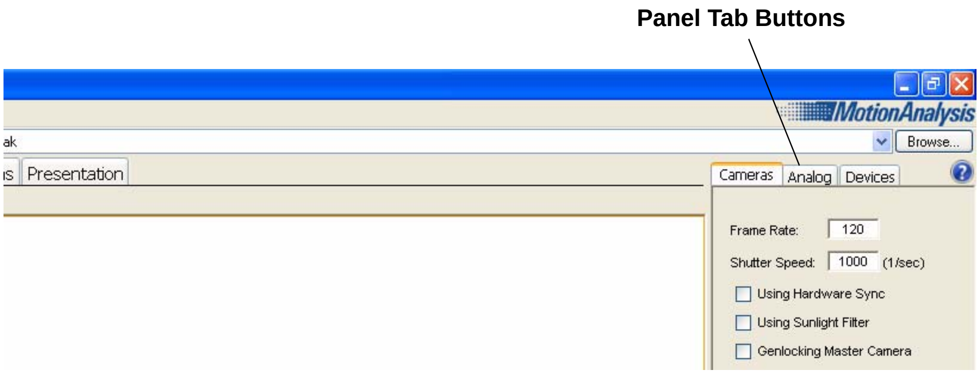
The fourth button, Post Process, activates Post Process mode and transforms **Cortex** into a tracked data editing tool.

The final two buttons, Model Edit and Plugins, are mode-less function buttons that present various tools without switching the program between the Real-Time mode and Post Process mode. Model Edit is used to define markers to create linkages.

Panel Tab Buttons

These buttons give you access to the various tools specific to the different phases of the motion capture session.

Figure 4-46. Panel Tab Buttons


Panel Tab Buttons
MotionAnalysis
ak
Browse...
s
Presentation
Cameras
Analog
Devices

Frame Rate: 120

Shutter Speed: 1000 (1/sec)

☐ Using Hardware Sync

☐ Using Sunlight Filter

☐ Genlocking Master Camera

Status Bar Messages

This feature, located in the lower left corner of the user interface, provides the status and confirmation of the software in its current processing state.

Real Time Dashboard

Refer to “Real Time Dashboard” on page 4-71.

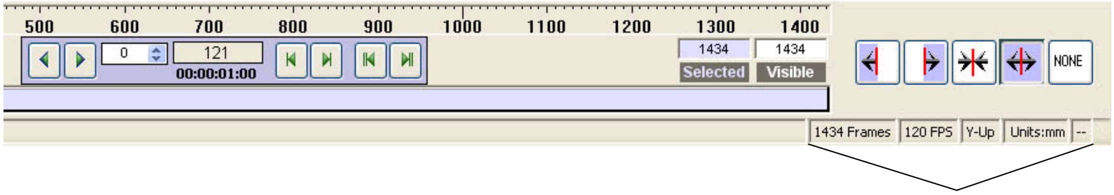
Information Center

The Information Center gives the following information for the current capture (from left to right):

- Cell 1: Number of frames in the current data set
- Cell 2: Frame rate in frames per second
- Cell 3: Up axis (e.g. Y up, Z up)
- Cell 4: Calibration units (e.g. mm)
- Cell5: Analog sample rate (samples/sec)

If you leave the mouse pointer over the message, its definition will pop up.

Figure 4-47. Information Center


500
600
700
800
900
1000
1100
1200
1300
1400
0
121
00:00:01:00
1434
1434
Selected
Visible
NONE

1434 Frames | 120 FPS | Y-Up | Units:mm | --

Information Center Cells 1 through 5

Setup Files (.cal Extensions)

Setup files are the main files used to set up and save all the variables involved with capturing data in **Cortex**. Every motion capture session must have a Setup file containing all system settings, equipment parameters, and other information related to the capture. This file contains both equipment parameters common to many different setups and calibration values unique to one particular session. Among the data found in a capture file are:

- the camera setup
- calibration setup and results
- camera type and parameters
- tracking parameters

Note: Data trials are stored in separate captures and their associated files.

In most cases, you will begin a session by loading an existing setup file, editing it as necessary, and saving it in the directory where the motion data is to be saved. Any time you calibrate the system or edit capture parameters, you should save the setup file to disk to retain the new information.

Cortex can read project files from older **EVaRT** and **Cortex** software versions for backwards compatibility.

Important

Setup files contain ASCII data and it may be useful to view them using any text editor, however, you should not edit them in a text editor as that can result in a corrupt file.

MarkerSet Files (.mars Extensions)

MarkerSet files contain the following elements:

- the markerset names and colors
- linkages and colors
- template information
- skeleton types and skeleton definitions

Viewing Sample Data

To become familiar with **Cortex**, we will start by replaying some sample data. This is done by loading a sample capture found in the Samples directory.

Sample Data Set

1. In live (real-time) mode, select **File > Load Capture (Live)...**
2. Navigate to: **Program Files\Motion Analysis\Cortex2\Samples\BioFeedTrak\GolfSwing.**
3. Double-click on **GolfSwing_1.cap** to load the Capture file.

Click the **Run** button on the Real Time Dashboard. At this point the action on the screen is a simulation of a live motion capture session. **Cortex** is processing the data from the stored raw video file, Reference Video file, and analog file generated by the force plates. If this were an actual real-time capture session, the action on the screen would be similar, but the data would be coming directly from the cameras and force plates.

Having loaded all of the related data files, we can now exercise all of the six different Graphics Panes available to us. We will now look at four simultaneously.

1. From the Menu Bar, select **Layouts > 4 Panes**.
2. Left-click on the empty lower-left pane. This action will select this pane.
3. Press **F1** on the keyboard or choose **View > Reference Video** to show the color reference video.

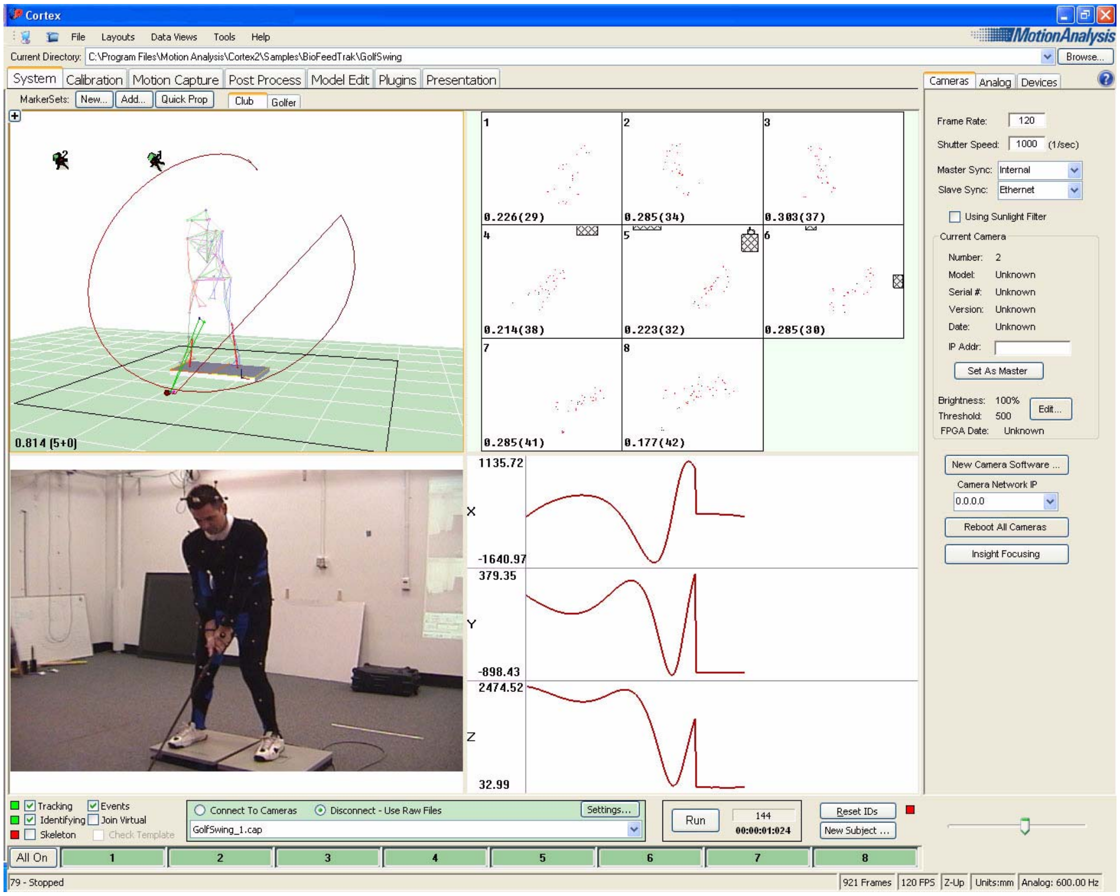
Note: If you are interested in the Reference Video option, contact your Motion Analysis sales representative.

4. Left-click on the empty upper-right pane.
5. Press **F2** on the keyboard or choose **View > 2D Display**.
6. Select **All On** to view the 2D display of each camera.
7. Left-click on the empty lower right pane.
8. Press **F4** on the keyboard or choose **View > Marker XYZ Graphs**.
9. Select any of the markers in the 3D Display to view their XYZ Graphs.

The displays can be controlled by hand if you click **Pause**, click on the FIFO slider on the Real Time Dashboard, and then drag from side to side. The “First In First Out” FIFO slider can only manipulate the 256 frames of data that are currently stored in the FIFO memory space (but not all of the data in the data set).

Figure 4-48 should be similar to what you see on your screen.

Figure 4-48. Viewing the Pre-Recorded Data


Cortex
File
Layouts
Data Views
Tools
Help
MotionAnalysis
Browse...
System
Calibration
Motion Capture
Post Process
Model Edit
Plugins
Presentation
MarkerSets:
New...
Add...
Quick Prop
Club
Golfer
Cameras
Analog
Devices
0.814 (5+0)
1
2
3
4
5
6
7
8
0.226(29)
0.285(34)
0.303(37)
0.214(38)
0.223(32)
0.285(30)
0.285(41)
0.177(42)
1135.72
X
-1640.97
379.35
Y
-898.43
2474.52
Z
32.99
Set As Master
Edit...
New Camera Software ...
Reboot All Cameras
Insight Focusing
Settings...
Run
Reset IDs
New Subject ...
All On

Current Directory: C:\Program Files\Motion Analysis\Cortex2\Samples\BioFeedTrak\GolfSwing

Frame Rate: 120

Shutter Speed: 1000 (1/sec)

Master Sync: Internal

Slave Sync: Ethernet

☐ Using Sunlight Filter

Current Camera

Number: 2

Model: Unknown

Serial #: Unknown

Version: Unknown

Date: Unknown

IP Addr:

Brightness: 100%

Threshold: 500

FPGA Date: Unknown

Camera Network IP: 0.0.0.0

☑ Tracking ☑ Events

☑ Identifying ☐ Join Virtual

☐ Skeleton ☐ Check Template

○ Connect To Cameras ● Disconnect - Use Raw Files

GolfSwing_1.cap

144

00:00:01:024

79 - Stopped | 921 Frames | 120 FPS | Z-Up | Units:mm | Analog: 600.00 Hz

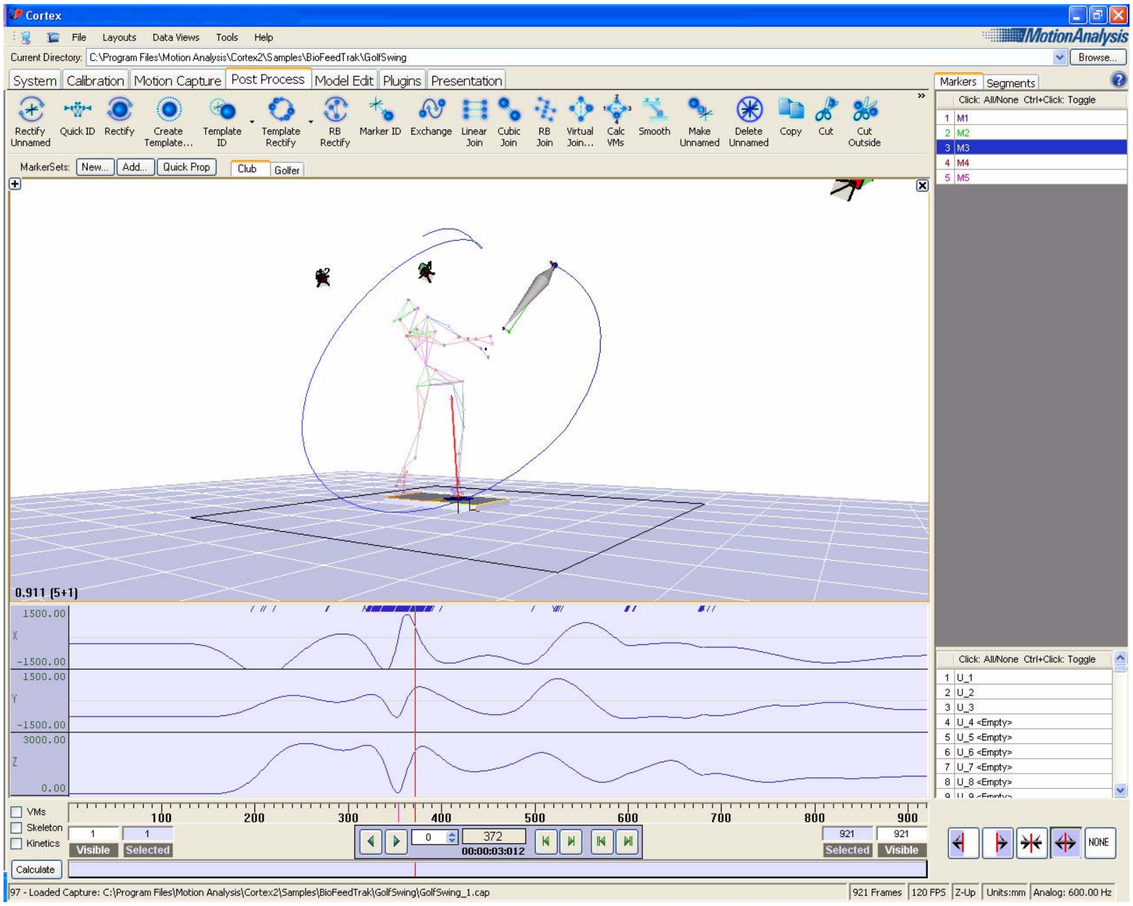
Cortex displays data somewhat differently when in Post Process mode. For instance, the analog displays become static graphs rather than having the oscilloscope style seen during collection and replays of raw data. The 2D Display and Skeleton Graphs become entirely unavailable but the XYZ Graphs become available. 3D stick figure images can be rendered for all of the data set rather than just the 256 frames available in Real-Time mode.

Post Process mode allows you to edit the tracked data generated during a motion capture session. Editing can be performed upon groups of markers or one marker at a time.

1. From the Menu Bar, select **File > Load Capture...**
2. Double-click on **GolfSwing_1.cap**.
3. Leave the 3D figure currently in the top pane in the 3D view.
4. From the Menu Bar, select **Layouts > 2 Panes: Top/Bottom**.
5. Left-click on the bottom pane. This action will select this pane.
6. Press **F4** on the keyboard or choose **Data Views > Marker XYZ Graphs**.
7. Select marker 15 on the MarkerSet panel (right side).

The two Graphics Panes used, often simultaneously, during a Post Process editing session are the 3D View and the XYZ Graphs shown here. Notice that the Post Process Dashboard has replaced the Real Time Dashboard. The data shown in the XYZ Graphs represents the X, Y, and Z coordinates of the selected markers throughout the capture period.

Figure 4-49. Viewing Tracked Data in Post Process Mode



Cortex
File
Layouts
Data Views
Tools
Help
MotionAnalysis
Browse...
System
Calibration
Motion Capture
Post Process
Model Edit
Plugins
Presentation
Rectify Unnamed
Quick ID
Rectify
Create Template...
Template ID
Template Rectify
RB Rectify
Marker ID
Exchange
Linear Join
Cubic Join
RB Join
Virtual Join...
Calc VMs
Smooth
Make Unnamed
Delete Unnamed
Copy
Cut
Cut Outside
MarkerSets:
New...
Add...
Quick Prop
Club
Golfer
Markers
Segments
Click: All/None Ctrl+Click: Toggle
1 M1
2 M2
3 M3
4 M4
5 M5
Click: All/None Ctrl+Click: Toggle
1 U_1
2 U_2
3 U_3
4 U_4 <Empty>
5 U_5 <Empty>
6 U_6 <Empty>
7 U_7 <Empty>
8 U_8 <Empty>
0.911 (5+1)
1500.00
X
-1500.00
1500.00
Y
-1500.00
3000.00
Z
0.00
100
200
300
400
500
600
700
800
900
VMs
Skeleton
Kinetics
Calculate
1
1
Visible
Selected
0
372
00:00:03:012
921
921
Selected
Visible
NONE

Current Directory: C:\Program Files\Motion Analysis\Cortex2\Samples\BioFeedTrak\GolfSwing

97 - Loaded Capture: C:\Program Files\Motion Analysis\Cortex2\Samples\BioFeedTrak\GolfSwing\GolfSwing_1.cap | 921 Frames | 120 FPS | Z-Up | Units:mm | Analog: 600.00 Hz

Pop-Up Menus

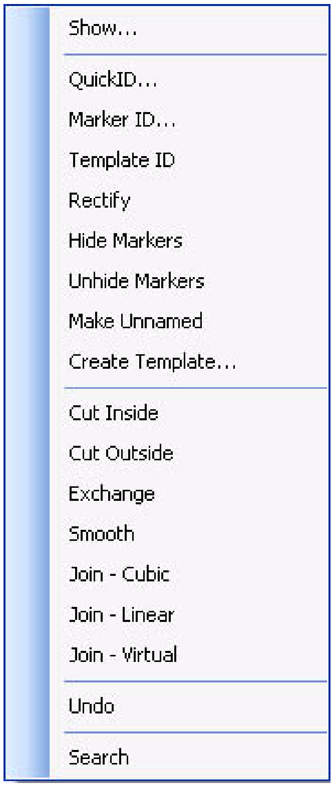
The Graphics Panes have viewing options and associated tools that can be accessed through pop-up menus. In all cases, the pop-up menus are activated with a click of the right mouse button while the pointer is in the display region.

3D View Pop-Up Menu

1. From the Menu Bar, select **Layouts > 1 Pane**.
2. From the Mode Buttons, left-click on the Post Process button in order to be in the Post Process mode.
3. If the 3D View is not visible, press **F3** on the keyboard or choose **Data Views > 3D-View** from the Menu Bar.
4. With the right mouse button, click on the 3D View.

The 3D View pop-up menu and descriptions of the tools are shown in Figure 4-50. These options are recorded in your INI file and are reloaded when you launch **Cortex**.

Figure 4-50. Post Process 3D View With Pop-Up Menu Items



Show options—cascading menu

Quick ID the markers sequentially

Marker ID the selected marker

ID marker(s) based on current template

Rectify marker(s) over the selected frame range

Hide selected marker(s) from view

Show selected marker(s)

Make selected marker(s) unnamed

Create a Template

Cut data in selected frames from the selected marker(s)

Cut data outside of the selected frames from the selected marker(s)

Exchange data between two markers over the selected frames

Smooth selected marker(s) over the selected frames

Join selected marker(s) over selected frames using cubic splines

Join selected marker(s) over selected frames using linear interpolation

Create a temporary virtual marker to fill in missing marker data

Undo last data edit action

Search data set for spikes and/or gaps as defined in the Options panel

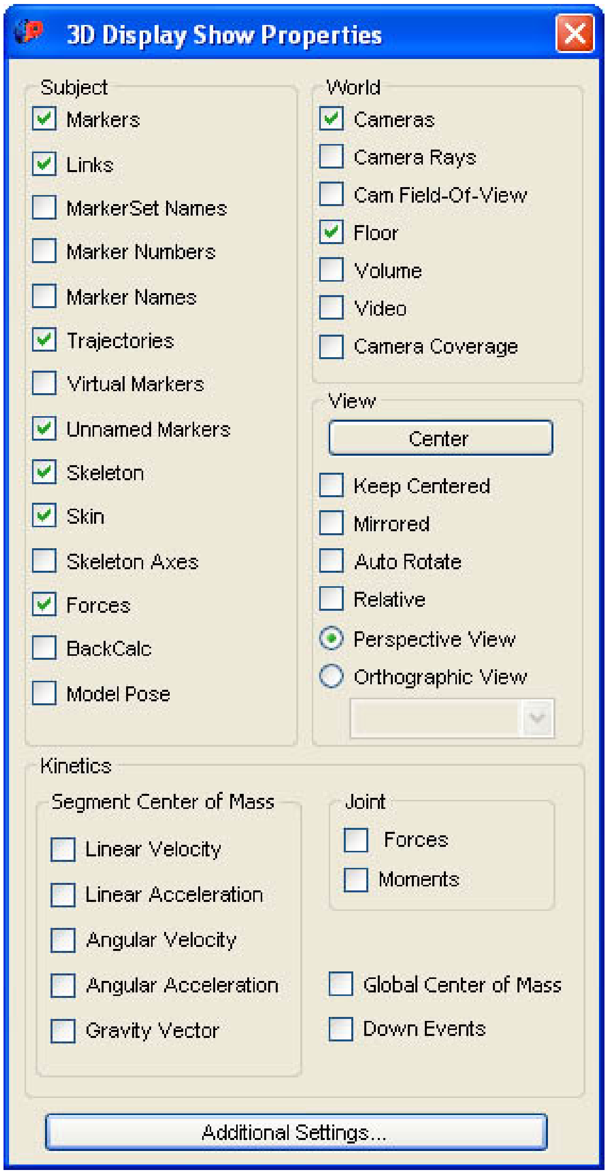
To see the 3D View options:

1. Choose the cascading **Show** item and another pop-up list will appear. Several of the view options will have check marks next to them indicating they are active. All of the Show items in the Show list are con-

sidered User Preferences and get stored to the **Cortex.ini** file when you exit the program or in your own custom preferences file from the **File > Profile Manager** function.

2. Choose items from the Show options menu and see the effects. These options are saved in profile settings and are reloaded when you launch **Cortex**.

Figure 4-51. 3D View Right-Click Pop-Up View Options



Subject
☑ Markers
☑ Links
☐ MarkerSet Names
☐ Marker Numbers
☐ Marker Names
☑ Trajectories
☐ Virtual Markers
☑ Unnamed Markers
☑ Skeleton
☑ Skin
☐ Skeleton Axes
☑ Forces
☐ BackCalc
☐ Model Pose

World
☑ Cameras
☐ Camera Rays
☐ Cam Field-Of-View
☑ Floor
☐ Volume
☐ Video
☐ Camera Coverage

View
☐ Keep Centered
☐ Mirrored
☐ Auto Rotate
☐ Relative
● Perspective View
○ Orthographic View

Kinetics
Segment Center of Mass
☐ Linear Velocity
☐ Linear Acceleration
☐ Angular Velocity
☐ Angular Acceleration
☐ Gravity Vector

Joint
☐ Forces
☐ Moments

☐ Global Center of Mass
☐ Down Events

Refer to the following page for descriptions of these options.

Subject

Markers—Displays all markers in the 3D View; Options... for length.

Links—Displays all links between markers in the 3D View.

MarkerSet Names—Displays the prj file name over the marker cloud.

Marker Numbers—Displays the ID numbers for all markers.

Marker Names—Displays the marker names (over the marker).

Trajectories—Displays the marker trajectories (in PP mode only).

Virtual Markers—Displays the virtual markers.

Unnamed Markers—Displays unidentified markers.

Skeleton—Displays the skeleton segments when they are defined.

Skin—Displays a selected skin.

Skeleton Axes—Displays the RGB/XYZ orientation for each bone.

Forces—Displays the force plate and force vectors off the force plates.

BackCalc—Shows the theoretical model pose markers relating to the bone in addition to the actual marker positions in Calcium skeleton bones.

Model Pose—Displays the model pose as defined in Create Template.

World

Cameras—Displays the motion capture cameras in the 3D View.

Camera Rays—Displays which cameras can see the selected marker(s).

Cam Field-Of-View—Displays the camera view for the selected camera(s) based on the focal length as set in the Lenses/Orientation tab.

Floor—Displays the virtual floor in the 3D View.

Volume—Displays the capture volume.

Video—Displays the digital video layered with the 3D View.

Camera Coverage—Displays the coverage of all cameras within the capture volume.

View

Center—Centers the display on the selected marker.

Keep Centered—3D View center follows the selected marker.

Mirrored—Mirrors the marker in the field of view.

Auto Rotate—Rotates around the capture area by selecting Play.

Relative—Toggles display to view from selected markers.

Perspective View—Selects the normal display options (adjust with mouse).

Orthographic View—Displays a flat view from either the X, Y, or Z axis perspective.

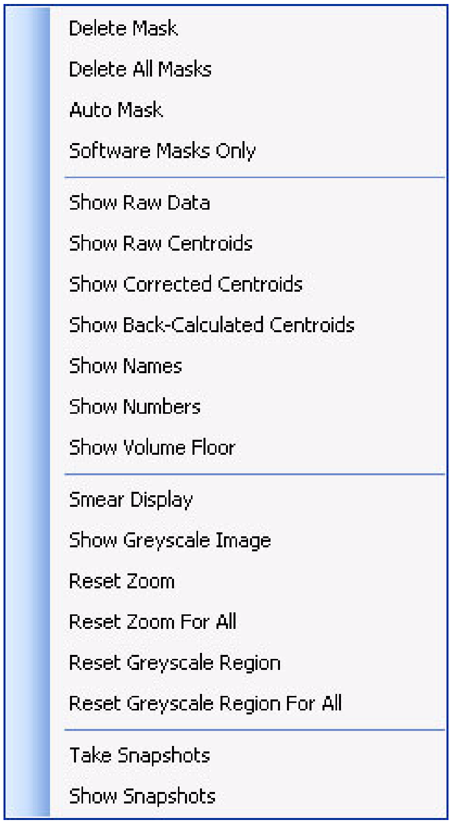
2D Camera View Pop-Up Menu

The 2D Display renders raw camera data as blobs and/or marker centroids. You can choose to see the centroids either with or without lens correction. To see the marker data as viewed from any one of the cameras or multiple cameras simultaneously,

1. Press **F2** on the keyboard or choose **View > 2D Display** from the Menu Bar.
2. Choose one or more cameras with **Ctrl** + click or **Shift** + click on the green camera buttons on the Real Time Dashboard or press **All On**.

To see the 2D Display options, right-click on the camera view 2D Display.

Figure 4-52. 2D Camera View Pop-Up View Options



Delete Mask	**Deletes selected mask**
Delete All Masks	**Deletes all masks in the 2D display for the selected camera**
Auto Mask	**Draws a mask around all items in the field of view**
Software Masks Only	**Allows the capture of raw data with any masks in 2D display**
Show Raw Data	**Toggles black raw data blobs**
Show Raw Centroids	**Toggles red, raw centroid crosses**
Show Corrected Centroids	**Toggles centroids corrected from lens distortion**
Show Back-Calculated Centroids	**Toggles image of centroid with 2D residual from triangulation**
Show Names	**Toggles marker names**
Show Numbers	**Toggles marker numbers**
Show Volume Floor	**Toggles outline of volume floor**
Smear Display	**Leaves smeared paths of the markers**
Show Greyscale Image	**Displays the greyscale image for the selected Raptor camera**
Reset Zoom	**Resets the selected camera to standard zoom settings**
Reset Zoom For All	**Resets all cameras to standard zoom settings**
Reset Greyscale Region	**Resets the Raptor greyscale image to full camera view**
Reset Greyscale Region For All	**Resets all cameras to standard greyscale image zoom settings**
Take Snapshots	**Takes greyscale snapshots for each Raptor camera**
Show Snapshots	**Shows the snapshots previously taken, overlaid on edge data**

Show Greyscale Image

This shows an 8-bit greyscale image from a 10-bit greyscale sensor. Markers (blobs) appear in blue for better separation. This used only with Raptor class cameras.

2D Display Shortcuts

- Double-clicking on a specific camera will show only that camera’s view. Double-clicking again will return to all camera views.
- Selecting **Shift + double-click** selects the view for only the enabled cameras within the system.

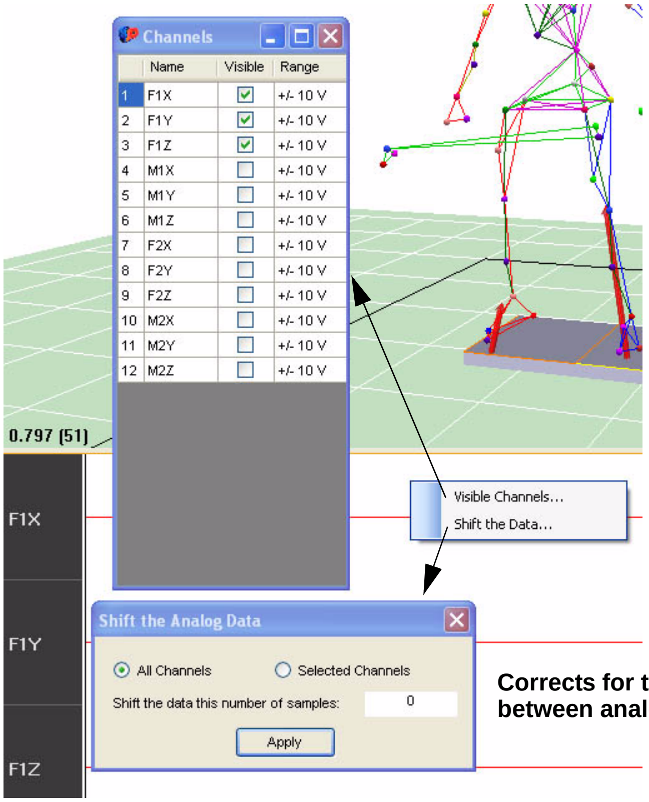
Analog Display Pop-Up Menu

For users collecting analog data from force plates, an Analog Display provides graphs of output from up to 192 analog channels. You can view any combination of channels at the same time. As a convenience, the Analog Display allows you to resize the label panel on the left side of the screen to accommodate long channel names. To open the Analog Display and modify the number of visible channels:

1. Press **F5** on the keyboard or choose **Data Views > Analog Graphs** from the Menu Bar.
2. With the right mouse, click on the Analog Graphs.
3. From the pop-up menu, choose **Visible Channels...**
4. Left-click on any one of the check marks in the Visible column.
5. Press **Shift** + click in the **Visible** column to toggle multiple channels.
6. Click directly on the **Visible** header cell to toggle all of the channels at once.

Figure 4-53. Analog Display With Right-Click Pop-Up View Options and Channels Table

Channels Table



	Name	Visible	Range
1	F1X	☑	+/- 10 V
2	F1Y	☑	+/- 10 V
3	F1Z	☑	+/- 10 V
4	M1X	☐	+/- 10 V
5	M1Y	☐	+/- 10 V
6	M1Z	☐	+/- 10 V
7	F2X	☐	+/- 10 V
8	F2Y	☐	+/- 10 V
9	F2Z	☐	+/- 10 V
10	M2X	☐	+/- 10 V
11	M2Y	☐	+/- 10 V
12	M2Z	☐	+/- 10 V

● All Channels ○ Selected Channels

Shift the data this number of samples: 0

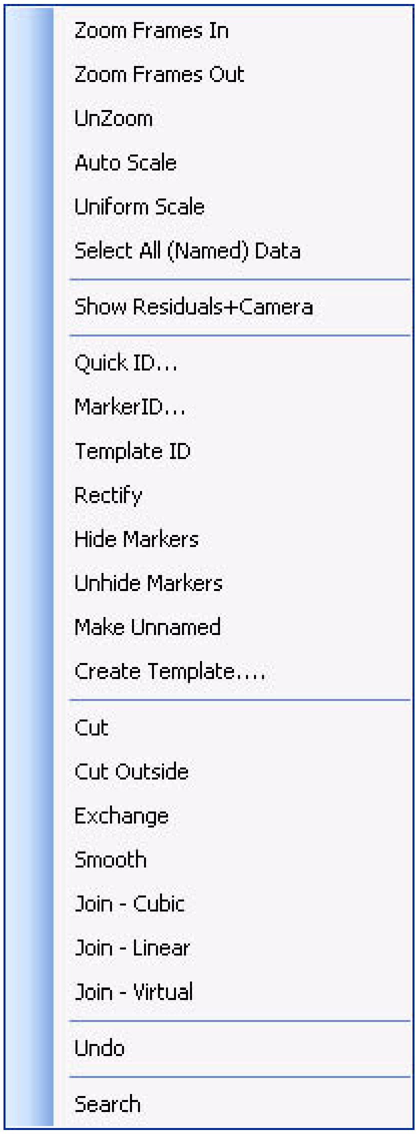
Corrects for time match problems between analog and video data

XYZ Graphs Pop-Up Menu

Post Process mode allows you to edit tracked data. The XYZ Graphs displays the positions of each marker in each frame. It also lets you select and edit those markers in any frame. A complete discussion of editing tracked data can be found in Chapter 10, Post Processing Panel. To see the XYZ Graphs and the pop-up menu of tools and view options:

1. Press **F4** on the keyboard or choose **View > XYZ Graphs**.
2. When in Post Process mode, right-click on the XYZ Graphs.

Figure 4-54. Post Process XYZ Graphs With Pop-Up View Options and Tools


Zoom Frames In
Zoom Frames Out
UnZoom
Auto Scale
Uniform Scale
Select All (Named) Data
Show Residuals+Camera
Quick ID...
MarkerID...
Template ID
Rectify
Hide Markers
Unhide Markers
Make Unnamed
Create Template....
Cut
Cut Outside
Exchange
Smooth
Join - Cubic
Join - Linear
Join - Virtual
Undo
Search

Zoom into the current frame range

Zoom out from the current frame range

Reset the amplitude display

Auto scale to visible channels

Applies uniform scale to all three X, Y, and Z panels

Select all frames in the data set

Show Residuals and Cameras plots

Quick ID the markers sequentially

Marker ID the selected marker

ID marker(s) based on current template

Rectify marker(s) over the selected frame range

Hide selected marker(s) from view

Show selected marker(s)

Make selected marker(s) unnamed

Create Template

Cut data in selected frames from the selected marker(s)

Cut data outside of the selected frames from the selected marker(s)

Exchange data between two markers over the selected frames

Smooth selected marker(s) over the selected frames

Join selected marker(s) over selected frames using cubic splines

Join selected marker(s) over selected frames using linear interpolation

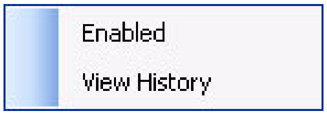
Create a temporary virtual marker to fill in missing marker data

Undo last edit on marker data

Search for spikes and/or gaps; as defined in the Search tab

Status Bar Pop-Up Menu

Figure 4-55. Status Bar Pop-Up Menu



Allows the StatusBarLog.txt file to collect new messages

Same action as double-clicking StatusBar line:
Pops the Status Bar history into a text window. This is sometimes useful in tracking down problems, especially if you are having data collection problems in real time

Digital/Reference Video Option (CortexDV Software)

The color Digital Video option allows you to record a time-matched Reference Video along with your motion capture trial on a separate computer. With this option, you will record a time-matched Reference Video AVI file with the same trial name in your motion capture folder. A separate computer is used in order to not burden your **Cortex** Host computer, which is an issue if your computer is too slow for the number of markers being tracked. For single person captures, you may connect the DV Camera directly to the **Cortex** Host computer. In this case, the **CortexDV** software is not needed. It is built into the **Cortex** software. You can run **CortexDV** on one or more computers and then capture multiple AVI files (multiple views). They will all have the same AVI file name. You may experience a small delay in frames from the **Cortex** software and the **CortexDV** software when capturing. The Reference Video display has a pop-up menu with one item, Adjust Frame Offset. This allows for time-matching data streams.

Note: The **CortexDV** software option is not to be confused with the AVI function in the **Motion Capture > Output** panel. This function creates an AVI file when you collect a trial within **Cortex**.

Reference Cameras Supported

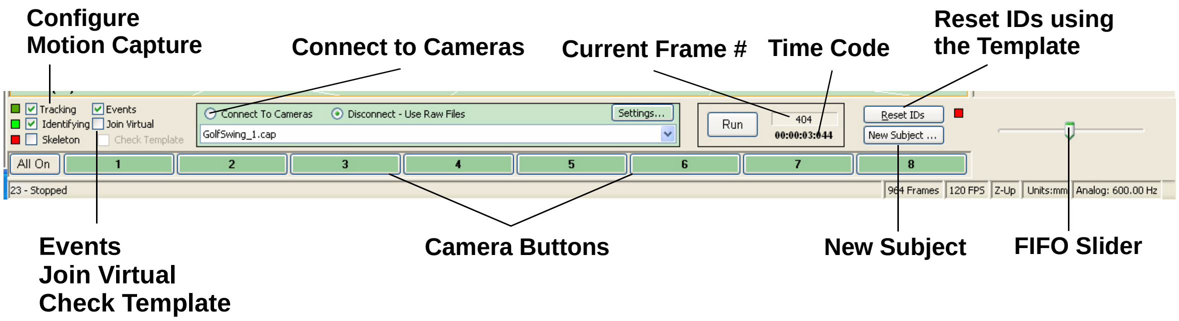
- NTSC (59.94 Hz)
- PAL (50 Hz)

Real Time Dashboard

The Real Time Dashboard is available when **Cortex** is in Real Time mode as opposed to Post Process mode. When you are capturing data in real-time, this dashboard provides the controls to manage a motion capture session. It also supports the replay and tracking of previously recorded data with a simulation of real-time from the raw VC camera files.

Note: To help you distinguish between the two modes (Real Time and Post Process), the dashboard and the floor color changes.

Figure 4-56. Real Time Dashboard


Configure Motion Capture
Connect to Cameras
Current Frame #
Time Code
Reset IDs using the Template
Tracking
Events
Identifying
Join Virtual
Skeleton
Check Template
Connect To Cameras
Disconnect - Use Raw Files
Settings...
GolfSwing_1.cap
Run
404
00:00:03:044
Reset IDs
New Subject ...
All On
1
2
3
4
5
6
7
8
23 - Stopped
964 Frames
120 FPS
Z-Up
Units:mm
Analog: 600.00 Hz
Events
Join Virtual
Check Template
Camera Buttons
New Subject
FIFO Slider

Cortex Dashboard Camera Button Colors

The Real Time Dashboard camera buttons inform you of the following:

Green	Camera is completely calibrated
Light green	Camera is completely calibrated and is selected
Yellow	Camera has undergone seed calibration but not wand calibration
Light yellow	Camera has undergone seed calibration and is selected
White	Camera is not calibrated
Dark grey	Camera is inactive—A right mouse click on the camera number will enable and disable that camera. **Note**—Camera #1 must remain enabled when you collect data to make sure you have a selectable VC1 file.

Tracking

The Tracking check box triangulates (tracks) the markers from frame to frame. You might want to uncheck this if your computer is not fast enough to calculate the marker coordinates or if your system is not calibrated for any reason. You can still collect raw VC files and track them at a later time. Collecting raw VC files is the highest priority thread in the motion capture Record mode to ensure that you do not lose your raw data.

Identifying

The Identifying check box identifies and names the tracked markers according to the current template. If you do not have a template, it is best to disable this function to keep the software from attempting to ID the data.

Skeleton

The Skeleton check box is set to calculate the skeleton using the currently active skeleton model.

Events

Executes (in real time) the once-per-frame event scripts for BioFeedTrak users.

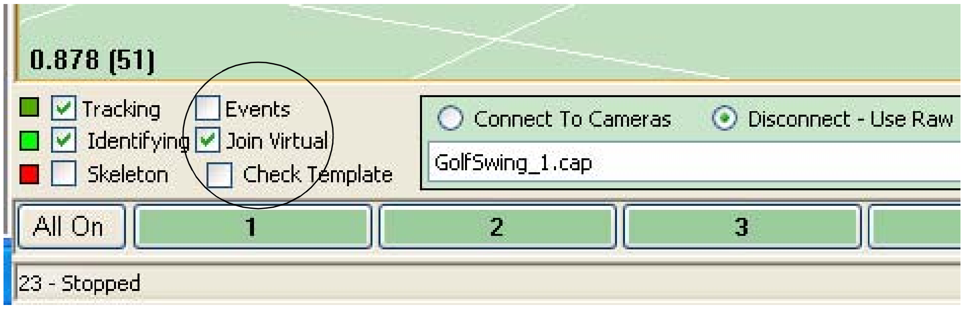
Check Template

Allows Join Virtual in real time only if the data meet the stretch criteria of the template.

Join Virtual

Join Virtual is an extremely powerful editing tool used to fill gaps in marker data with simulated data based on the relationship (positional interpolation) with other markers on or near the particular problem segment. This positional interpolation is defined by the settings in the **Tools > Virtual Marker Definitions** function.

Figure 4-57. Join Virtual Check Box



0.878 (51)

☑ Tracking
☑ Identifying
☐ Skeleton
☐ Events
☑ Join Virtual
☐ Check Template

○ Connect To Cameras
● Disconnect - Use Raw

GolfSwing_1.cap

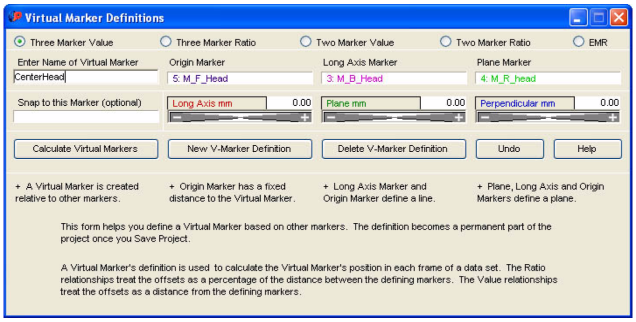
23 - Stopped

The concept behind the Join Virtual and the Virtual Marker definitions are the same and are much more stable and more useful than the classic Rigid Body data filling mechanisms. The reason is that you get to choose two sets of three markers, in decreasing importance, that determine the replacement data. These three markers are:

1. the Origin Marker
2. the Long Axis (Y) Marker
3. the Plane (XY) Marker

The two sets of virtual marker definitions allow you to continue generating virtual marker data if one of the definition markers is not being tracked. For the Join Virtual function to work properly, you will need a minimum of three different support markers among the six spots to fill. If you are in Streaming mode from cameras or VC files, the first definition set is used. If you are in Post Process mode, you may choose which definition set works best.

Figure 4-58. Virtual Marker Definitions



● Three Marker Value

Enter Name of Virtual Marker: CenterHead
Origin Marker: 5: M_F_Head
Long Axis Marker: 3: M_B_Head
Plane Marker: 4: M_R_head
Snap to this Marker (optional):
Long Axis mm: 0.00
Plane mm: 0.00
Perpendicular mm: 0.00

+ A Virtual Marker is created relative to other markers.

+ Origin Marker has a fixed distance to the Virtual Marker.

+ Long Axis Marker and Origin Marker define a line.

+ Plane, Long Axis and Origin Markers define a plane.

This form helps you define a Virtual Marker based on other markers. The definition becomes a permanent part of the project once you Save Project.

A Virtual Marker's definition is used to calculate the Virtual Marker's position in each frame of a data set. The Ratio relationships treat the offsets as a percentage of the distance between the defining markers. The Value relationships treat the offsets as a distance from the defining markers.

When running live, the Join Virtual tool only uses the first VM Join definition of the two that you are allowed. However, 4 passes are made over the list on each frame so that if a definition depends on another then after the first pass the second marker is reconstructed so that the first marker can be reconstructed on the second pass. It also works this way in Post Process mode when you have multiple markers selected and do a Join Virtual function.

Streaming vs. Post-Processing

The Real Time Join Virtual check box (in the Real Time dashboard) eliminates what might be seen as a possible “pop” on the frame when the real marker re-appears. At that time, the Virtual Marker filling the gap is no longer used.

In the post-processing Join Virtual mechanism, the offsets between the marker to join and the Join Virtual Origin Marker are measured both at the start of the gap and the end of the gap, and a linear interpolation is used for all in between data points. The result is always a perfectly fluid transition on both ends of the gap.

The Join Virtual mechanism is a powerful tool in creating and editing data quickly with good results. It is the result of working with our customers to define and develop techniques to get good motion capture data quickly and efficiently.

Reset IDs Button

The Reset IDs button forces the current template to be used for that specific frame. It is used when a marker is misidentified. Press this if you see markers that are incorrectly identified. If this fails to fix the problem, you may need to create a new template or adjust the marker set to be less symmetric. After pressing the **New Subject...** button and with the Pose ID window open, the Reset ID button will use the current marker pose to identify the markers.

New Subject Button

This feature allows the software to automatically identify markers based on a Model Pose that you create when you make a template. The result is that if you use the same marker set repeatedly, you will not have to ID the new person each time the marker set is used. The marker identification is automatic and instant, saving you time.

The Model Pose has its own kind of generalized template that is used to automatically identify a new person when they appear in the field of view. It saves the steps of using the Quick ID feature to identify a new person in order to make a template for them. The Template ID feature works in the Real-Time mode when you are connected to cameras or it works when you are tracking the data from VC files after the collection.

Note: The current template is size specific, so a new person or a new arrangement in the markers will not generally work for automatically identifying the markers.

When you click **Update Template**, it also updates the Model Pose.

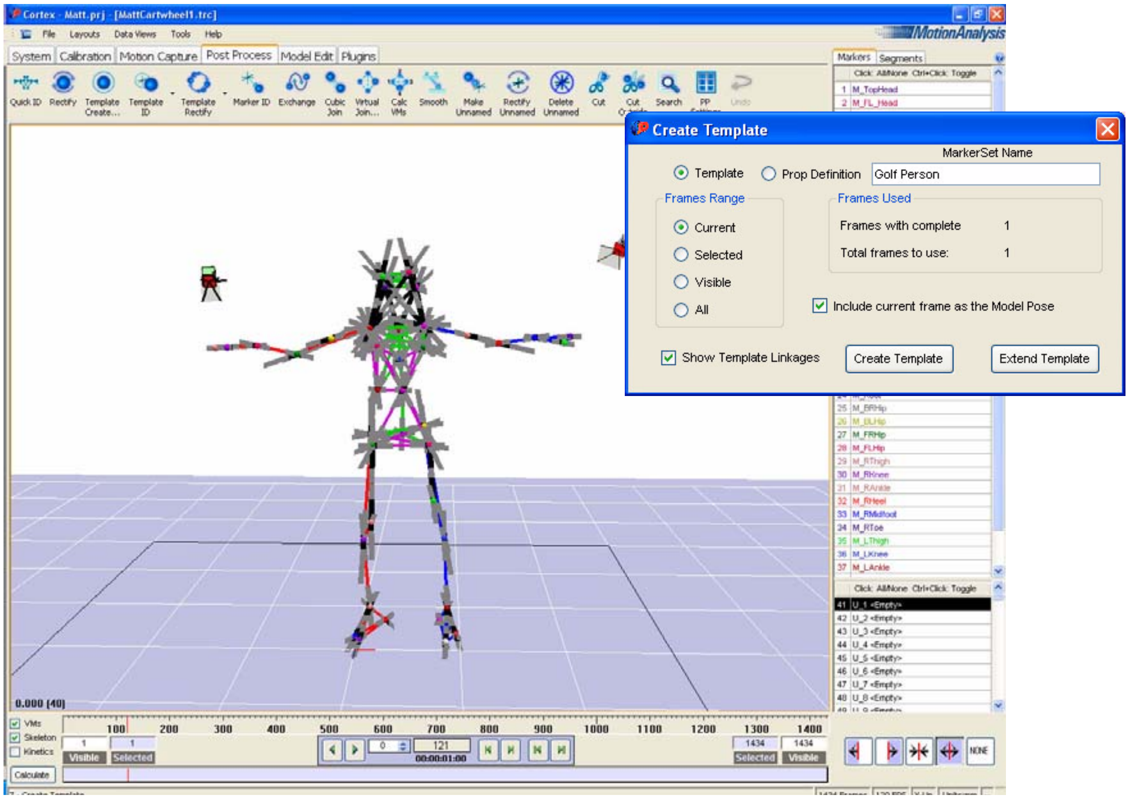
To use the **New Subject** button, use the following procedure:

1. Get a Range-of-Motion Trial.
   a. Get a good range of motion trial for your current tracks in Post Process, Quick ID, and edit so there are no mistakes or marker switches. The data does not have to be highly complex, but it should represent the minimum and maximum stretching for all limbs. Jumping Jacks are a good example of the kind of dynamic motion that has worked well and does not obscure the markers or require editing. For simple walking motion, a single walking trial will suffice.
   b. Select one frame that represents a standard or neutral pose position. This can be with the arms down or the arms out, feet apart or together, but where no markers will be hidden. You will want it to be a standard position that the next person will be able to repeat quickly and simply. Have them face a certain direction that will also be easily repeatable for the next person. (along the +X axis for example).
2. Create a Template.
   a. Select **Post Process > Create Template.**
   b. Select Body Template and check the box **Include current frame as the Model Pose** and select the correct range of frames where you have good data.

c. Save your capture file which now has a new feature called the Model Pose stored in it. You may want to use the word “Pose" in the capture file name to distinguish it from earlier versions without the pose, but that is not necessary. The normal template will also work for this person.

Note: You can choose to see the Model Pose in your current capture by right-clicking in the 3D View and then selecting **Show > Show Model Pose**.

Figure 4-59. Create Template Window Showing Template Linkages


Cortex - Matt.prj - [MattCartwheel1.trc]
File
Layouts
Data Views
Tools
Help
MotionAnalysis
System
Calibration
Motion Capture
Post Process
Model Edit
Plugins
Quick ID
Rectify
Template Create...
Template ID
Template Rectify
Marker ID
Exchange
Cubic Join
Virtual Join...
Calc VMs
Smooth
Make Unnamed
Rectify Unnamed
Delete Unnamed
Cut
Search
Markers
Segments
0.000 (40)
VMs
Skeleton
Kinetics
Calculate
Visible
Selected

Create Template

MarkerSet Name

● Template ○ Prop Definition Golf Person

Frames Range

● Current

○ Selected

○ Visible

○ All

Frames Used

Frames with complete 1

Total frames to use: 1

☑ Include current frame as the Model Pose

☑ Show Template Linkages

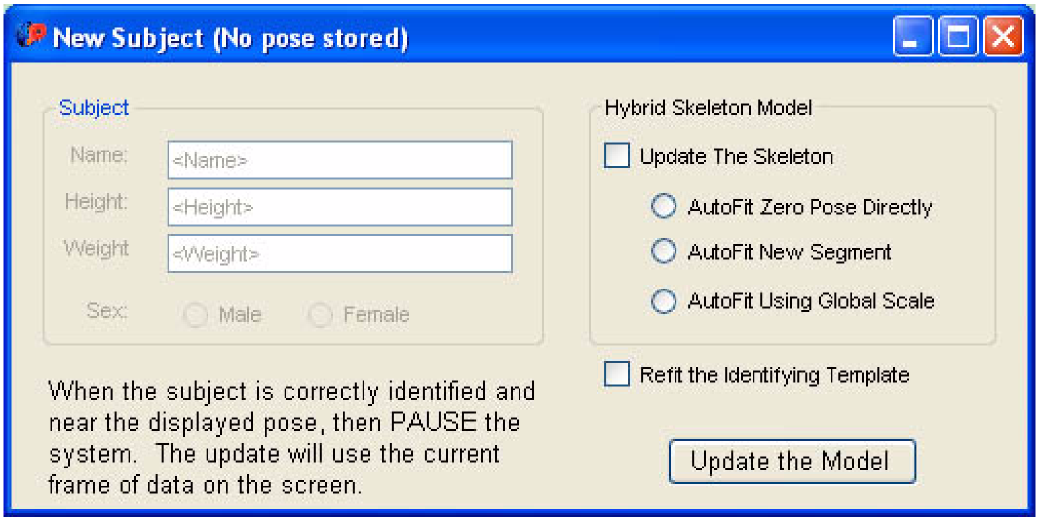
Create Template Extend Template

Getting Auto ID to Work: Tuning and Updating the Template

If the person who was used to create the template moves some markers, or if a new person comes out with the same marker configuration (but in slightly different locations), you will want to update the template to the new marker locations. This will make sure that your RealTime tracking and the Template ID and Template Rectify functions in Post Process will be at an optimum performance level.

Activate the Motion Capture tab and then select **Connect to Cameras** (or select the VC files) and then select **New Subject...**. This will bring up the Pose ID dialog box (below) and the Model Pose stick figure appears in the 3D View.

Figure 4-60. New Subject... Interface

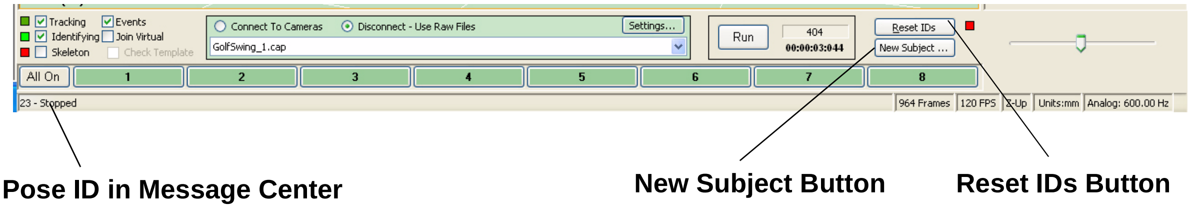

New Subject (No pose stored)
Subject
Name: <Name>
Height: <Height>
Weight <Weight>
Sex: ○ Male ○ Female
Hybrid Skeleton Model
☐ Update The Skeleton
○ AutoFit Zero Pose Directly
○ AutoFit New Segment
○ AutoFit Using Global Scale
☐ Refit the Identifying Template
Update the Model

When the subject is correctly identified and near the displayed pose, then PAUSE the system. The update will use the current frame of data on the screen.

At this point the old Template ID feature is not working, but instead the generalized automatic Pose ID feature is looking to identify the unnamed markers. As soon as the ID is recognized and catches, you will see two stick figures; the static one from the Model Pose and one that is the newly ID-ed person that is moving. If the person is not ID-ed right away, have them face the same direction and assume the same general posture as seen in the Model Pose. The Auto ID feature works as long as the person is facing within about 45° of where the Model Pose was recorded.

The status display in the lower left tells you how fast the ID process took. A small number is a fast ID, a bigger number would be slower, but still working. Using the Reset IDs button on the lower right will force the software back to the Pose ID if something gets switched and you want to correct it.

Figure 4-61. Pose ID in Message Center and Reset IDs Button



☑ Tracking ☑ Events
☑ Identifying ☐ Join Virtual
☐ Skeleton ☐ Check Template

○ Connect To Cameras ● Disconnect - Use Raw Files

GolfSwing_1.cap

404
00:00:03:044

23 - Stopped

964 Frames | 120 FPS | Z-Up | Units:mm | Analog: 600.00 Hz

Updating the Template also updates the Model Pose, so before clicking the **Update Template** button, you should again get your new person into something close to the Pose position. The changes can be saved in your capture file if you want.

After you Update the Template, the template is then re-sized to the new person's limb lengths and marker placements. Note that the changes in the lengths, as recorded in the range of motion trial is still saved, so that you will not need to do another range of motion. The new template should work well for many sizes and marker adjustments using the same marker set.

Recommended Procedure

1. Create your own library capture file for the marker set. This library contains your markers set with the template created from your range of motion capture files, and your Pose ID.
2. When creating the library capture file, start with the range of motion capture type file in the neutral position, facing +X, arms down, feet slightly apart to show all the markers. That would be frame 1 to make the Pose ID easy to find. When you create the Template for your library file, you would have Frame 1 selected as the current frame and you would check **Include Current Frame as Model Pose** for frame number 1. You should only need to do this once per marker set.
3. When the New Subject comes into the volume, they should be standing in the Pose position facing the same +X[1] and you select **New Subject...** The PoseID will show and you should then select **Pause**. The stick figure should snap to, looking like the Model Pose.
4. Update the template, then select **Pause.** Check that the ID is correct and that the position is similar to the Pose. You can use the FIFO slider to make adjustments. Save the capture file and then select **Run**.

Get a Range of Motion Trial and Make a Template

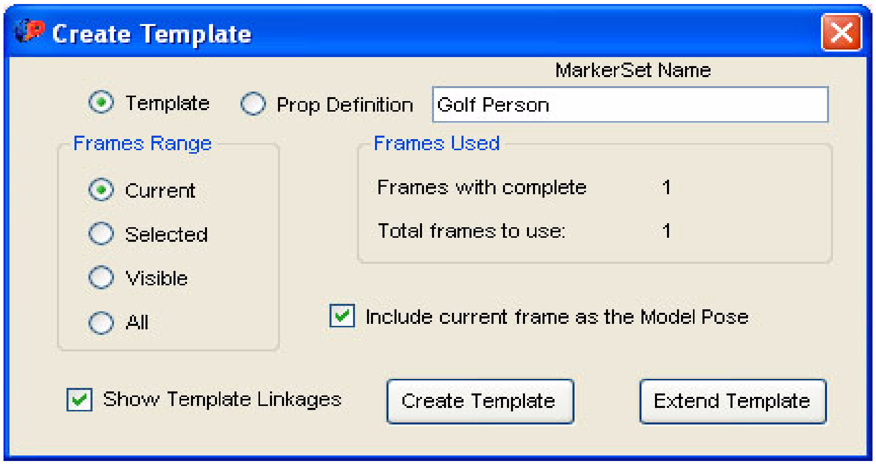
1. You will first want to obtain a good range of motion trial and set it as your current tracks in Post Process.
2. You will then need to Quick ID and edit the trial, if needed, so there are no mistakes or marker switches. It does not have to be overly complex, but it should represent the minimum and maximum stretching for all limbs. Jumping jacks is a good example of the kind of dynamic motion that has worked well and does not obscure the markers or require editing. For simple walking motion, a single walking trial will be sufficient.

---

[1] Facing +Z or any other direction also works as long as Pose ID is used in the same orientation

3. Select one frame that represents a somewhat standard or neutral pose position. This can be with the arms down or the arms out, feet apart or together, but where no markers will be hidden. You want it to be a "standard" position that the next person will be able to repeat quickly and simply. Have the subject face a certain direction that will also be easily repeatable for the next person. (along the +X axis for example).

Figure 4-62. Create Template Interface



● Template ○ Prop Definition

MarkerSet Name: Golf Person

● Current
○ Selected
○ Visible
○ All

Frames with complete 1
Total frames to use: 1

☑ Include current frame as the Model Pose

☑ Show Template Linkages

Create a Template

1. Select **Post Process > Create Template**.
2. Select **Body Template**.
3. Activate the **Include current frame as the Model Pose** check-box and select the correct range of frames where you have good data.
4. Save your capture file which now has a new feature called Pose stored in it. You may want to use the word Pose in the capture file name to distinguish it from earlier versions without the pose, but that is not necessary. The normal template will work for this person.

Using the Pose ID Feature

This feature allows the software to automatically identify markers based on a Model Pose that you create when you make a template. The result is that if you use the same marker set repeatedly, you will not have to ID the new person each time the marker set is used. The marker identification is automatic and instant, saving you time.

The Model Pose has its own kind of generalized template that is used to automatically identify a new person when they appear in the field of view. This generalized template depends on the person facing the same direction as the stored Pose ID and having the markers in the same general locations with respect to each other. You save the Pose ID from one frame of data and is saved in your capture file. It saves you the steps of using the "Quick ID" feature to identify a new person in order to make a template for them. The Auto ID feature works in the RealTime mode when you are connected to cameras or it works when you are tracking the data from VC files after the collection.

The following are basic steps on how to use the Pose ID function.

Connect Cameras Button

The Connect Cameras button will activate all the cameras used in a motion capture session. A pop-up message announces the number and type of cameras, A-D units, Reference Video cameras, and time code reader if present.

Disconnect - Use Raw Files Button

The Raw Video button will tell the program to simulate a live motion capture session from previously captured Video Camera (VC) files. It also allows you to tack and record to TRB or TRC trials for which you have raw VC files.

Raw Settings... Button

This button opens the **Settings > Playback** interface. For more information, please reference “Tools > Settings > Playback Tab” on page 4-29.

Run Button

The **Run** button will start the streaming of live camera data or start the simulation of a motion capture session from existing raw VC files.

The **Run** button has the following functions:

1. If you are connected to the cameras, it starts the data steaming from the cameras. You are able to record the Raw Video VC files as set in the motion capture Output panel. Check your 2D views to be sure the cameras, masks, and thresholds are all set properly.

2. If **Enable Tracking** is checked, you will see the marker data appear in the 3D View. This requires that the system has been calibrated. You are then able to record VC files, and TRC or TRB files.
3. If **Enable Identifying** is checked, you will see the colored markers and the stick figures in the 3D View. This requires that the system is calibrated and a template is defined and operating. You are then able to record VC files, and TRB or TRC files.
4. Tracking from Raw Video files—If you are not connected to the cameras, you have the full range of option 2 or option 3 above from your previously collected Raw Video VC file.

Time Code Counter

The Time Code Counter displays the frame number in HH:MM:SS:Frame (hour, minute, second, frame) format. If you have the optional Time Code Reader card installed in your computer, this displays the current Time Code value when you are in the Motion Capture mode and connected to the cameras.

Frame Counter

The Frame Counter displays a count of the total number of frames in the data set.

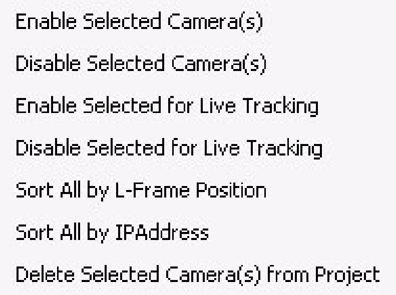
Camera Buttons

You can select each camera by clicking on it's respective numbered button that is listed across the Real Time Dashboard. Clicking on a camera button will either activate or de-activate that camera for setup features.

Right-Click Camera Buttons

Right-clicking on any of the camera buttons will open a function menu with various commands for that specific camera. The menu and a description of each command is shown in Figure 4-63.

Figure 4-63. Camera Buttons Right-Click Menu

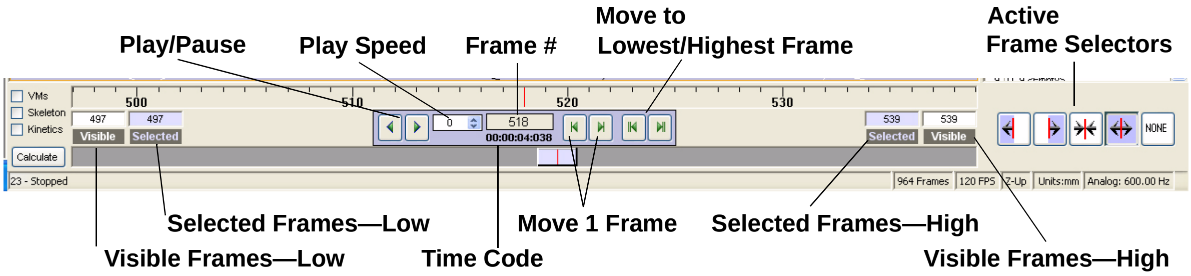


Enable Selected Camera(s)	**Enables the selected camera to capture data (if disabled)**
Disable Selected Camera(s)	**Disables the selected camera from capturing data**
Enable Selected for Live Tracking	**Enables the camera to capture and display data in Real Time**
Disable Selected for Live Tracking	**Disables the camera from data collection in Real Time only**
Sort All by L-Frame Position	**Camera numbers are sorted in a counter-clockwise order**
Sort All by IPAddress	**Camera numbers are sorted by IP address starting from lowest**
Delete Selected Camera(s) from Project	**Deletes the selected camera from the capture file**

Post Process Dashboard

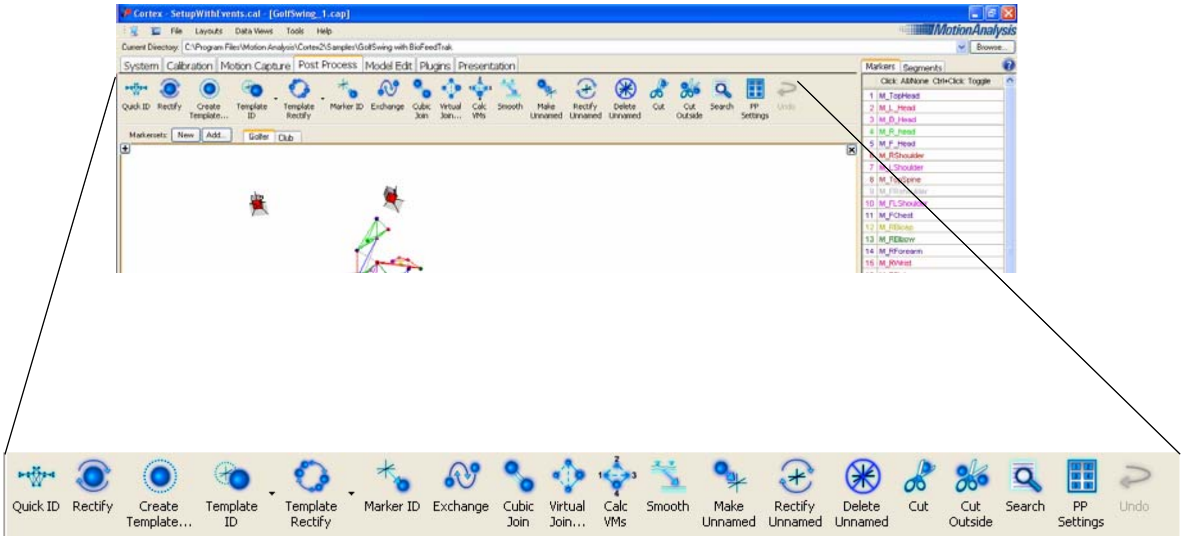
The Post Process Dashboard is available when **Cortex** is in Post Process mode as opposed to Tracking mode. After you have generated and saved tracked data, this becomes available to help manage a data editing session. It controls the range of visible frames and the range of selected frames to be edited. It also provides several controls for playing through the tracked data and choosing a current frame. This dashboard is described further in Chapter 10, Post Processing Panel.

Figure 4-64. Post Process Dashboard


Play/Pause
Play Speed
Frame #
Move to Lowest/Highest Frame
Active Frame Selectors
VMs
Skeleton
Kinetics
Calculate
500
510
520
530
497
497
Visible
Selected
0
518
00:00:04:038
539
539
Selected
Visible
NONE
23 - Stopped
964 Frames
120 FPS
2-Up
Units:mm
Analog: 600.00 Hz
Selected Frames—Low
Visible Frames—Low
Time Code
Move 1 Frame
Selected Frames—High
Visible Frames—High

Post Process Tool Strip

Figure 4-65. Post Process Tool Strip


Quick ID
Rectify
Create Template…
Template ID
Template Rectify
Marker ID
Exchange
Cubic Join
Virtual Join…
Calc VMs
Smooth
Make Unnamed
Rectify Unnamed
Delete Unnamed
Cut
Cut Outside
Search
PP Settings
Undo

Post Process Tool Strip Icons

For a listing and description of all Post Process Tool Strip Icons, reference “Post Process Tool Strip” on page 8-11

Zooming, Rotating, and Translating in the 3D View

Zooming and translating a display can occur in both the 3D View and the XYZ Graphs. Rotating only occurs in the 3D View. Choosing **Help > Hot Keys and Tips** from the Menu Bar will bring up an online table describing how these features work.

Zoom—In the 3D View, zooming is accomplished if you:

1. Hold the **Alt** key down.
2. Hold both the **left** mouse and **middle** mouse buttons down.
3. Move the mouse forward or left to zoom out and backward or right to zoom in.

Rotate—In the 3D View, rotating is accomplished if you:

1. Hold the **Alt** key down.
2. Hold the **left** mouse button down.
3. Move the mouse in any direction.

Translate—In the 3D View, translating is accomplished if you:

1. Hold the **Alt** key down.
2. Hold the **middle** mouse button down.
3. Move the mouse in any direction.

In the XYZ Graphs, time zooming is done in terms of frames (time) or amplitude. If you want to zoom in frames, there are two methods. 1) If one or no frames are selected, zooming is done relative to the current frame. 2) If two or more frames are selected, zooming is done relative to the selected frames.

Time Zoom Method 1

1. Click on the **Post Process** button among the Mode Buttons.
2. Press **F4** or choose **View > XYZ Graphs** from the Menu Bar.
3. Left-click on **None** in the lower right corner below the marker list. Now, no frames are selected.
4. Left-click anywhere on the XYZ Graphs to set the Current Frame which is indicated by the red line.
5. To zoom in, press the “Zoom Frames In” hot key (default is **I**) or by right-clicking in the XYZ Graphs and selecting “Zoom Frames In” from the pop-up menu.
6. To zoom out, press the “Zoom Frames Out” hot key (default is **O**) or by right-clicking in the XYZ Graphs window and selecting “Zoom Frames Out” from the pop-up menu.
7. Unzoom time: Double-click on the Time Slider on the Post Process Dashboard to zoom out completely making all frames visible. The Post Process Dashboard Visible boxes will now have a **1** and the highest frame number displayed.

Time Zoom Method 2

The second method of zooming in frames is described as follows:

1. Hold the **middle** mouse button down in the XYZ or the Analog Graphs.
2. Drag the mouse to the right or left to select any number of frames.
3. To zoom in, press the “Zoom Frames In” Hot Key (default is I) or by right-clicking in the XYZ Graphs window and selecting “Zoom Frames In” from the pop-up menu.

Amplitude Zoom

Zooming amplitude is done relative to the closest data point and frame nearest to the location you initially click on. You can optionally zoom into the data in the Current Frame regardless of where your mouse cursor is on the screen. This option is a User Preference and it can be set by launching the Options Form from the Post Process tab.

1. Hold the **Alt** key down.
2. Hold both the **left** mouse and **middle** mouse buttons down.
3. Move the mouse forward and backward.

In the XYZ Graphs, translating is accomplished if you:

1. Hold the **Alt** key down.
2. Hold the **middle** mouse button down.
3. Move the mouse in any direction.

Selecting Markers, Virtual Markers, Linkages, and Segments

Markers can be selected by the following:

1. Clicking on the markers seen on the 3D View
2. Double-clicking on the markers seen in the XYZ Graphs
3. Clicking on the markers listed on the Marker Grids (which are a part of the Post Process tab, the **Model Edit > Markers** panel, and the **Model Edit > Tree View**)

Note: All of the conventional **Shift** + click and **Ctrl** + click techniques to select multiple items are supported in this software.

Time Code

SMPTE Time Code and Cortex Overview

SMPTE Code reads as HH:MM:SS:FF, which is Hours:Minutes:Seconds:Frame. Frame numbers are 0 to 29 in NTSC and 0 to 24 in PAL. When you capture at a higher motion capture rate such as 60 or 120 Hz, there are multiple motion capture VC frames per Reference Video frame. The software takes care of that so if you record your VC files at 60 Hz, the VC frame advances twice for every single frame advance in the Reference Video when you play it back or step through the data. The SMPTE time code is visible on the Real Time Dashboard.

Using the Time Code Reader Option

Motion Analysis digital cameras can use the Time Code Reader (PCI version) card, installed into the **Cortex** Host computer. It reads the LTC (Longitudinal Time Code) from the RCA audio connector on the Time Code card, creating a **trialN.tc** file (time code) when you collect a **trialN.vcX** dataset. It is automatic if you have the Time Code Reader option (card) installed in your **Cortex** computer. There is a BNC type connector on the card as well; it appears that the Time Code Reader will genlock to the black burst video signal, but that is not needed. **Cortex** reads the current time code when the data collection is started and time stamps it into the TC file. The current time code also displays on the Post-Process Dashboard.

A simple test program called **TimeCodeReader.exe** is distributed with the latest **Cortex** releases. It is a stand-alone program which launches, and in a small window reads the current value of the Time Code Reader in the **Cortex** Host computer. It is useful for testing to see if the Time Code reader is working. Without a card installed, it just leaves a blank display. With a time code reader card installed, it displays the current time code, static or not. When the time code starts to advance, you can immediately see it.

Using the Time Code in Post Processing

If you load a TRB or TRC file that has an associated TC file, then the Post-Processing Dashboard will lock the time code onto the time code display. You can step forward or backwards in time or push the play button and the time code reads accurately. If you switch back to the Motion Capture tab and are connected to the cameras, you will see the current time code. If you are in the Motion Capture tab and are not connected to the cameras, but using Raw Video Files, you will see the Time Code associated with the Raw Video File.

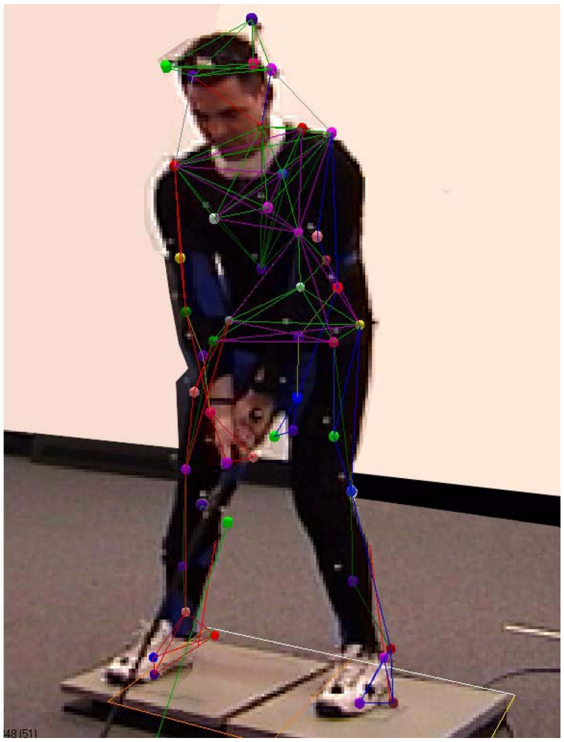
Time Code and the Digital Video (CortexDV) Option

The Digital Video option can be used with the Time Code. In our current software, the only way to record the time code is with the Time Code Reader card. Some cameras have Time Code capability within the camera, but those time codes are not recorded with the DV (Digital Video) option. The Time Code must be connected to the Time Code Reader card to have a TC file created and hence be time coded.

Live Video Backdrop

The Live Video Backdrop allows you to set your streaming live video as the backdrop to your 3D View. To activate this function, right-click in the 3D View and select **Show Video**.

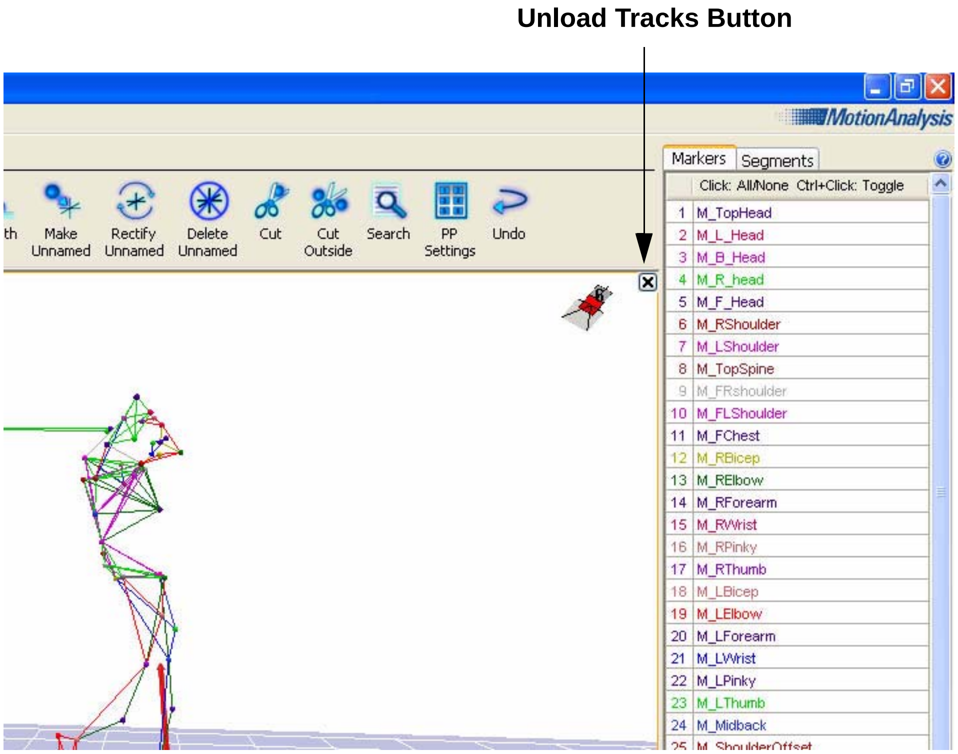
Figure 4-66. Live Video Backdrop



Unload Tracks Button

This button provides a quick method to unload, or not save any changes to, the Tracks files which have been edited in the Post Process mode.

Figure 4-67. Unload Tracks Button


Unload Tracks Button
MotionAnalysis
th
Make Unnamed
Rectify Unnamed
Delete Unnamed
Cut
Cut Outside
Search
PP Settings
Undo
Markers
Segments
Click: All/None Ctrl+Click: Toggle

1	M_TopHead
2	M_L_Head
3	M_B_Head
4	M_R_head
5	M_F_Head
6	M_RShoulder
7	M_LShoulder
8	M_TopSpine
9	M_FRshoulder
10	M_FLShoulder
11	M_FChest
12	M_RBicep
13	M_RElbow
14	M_RForearm
15	M_RWrist
16	M_RPinky
17	M_RThumb
18	M_LBicep
19	M_LElbow
20	M_LForearm
21	M_LWrist
22	M_LPinky
23	M_LThumb
24	M_Midback
25	M_ShoulderOffset

Chapter 5

System Tab

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Getting Started

Before using **Cortex**, you must configure your software to match the overall system. The System tab provides tools to do this. The camera settings do not need to be reset before each and every motion capture session but they do need to be reset after changes are made to the cameras.

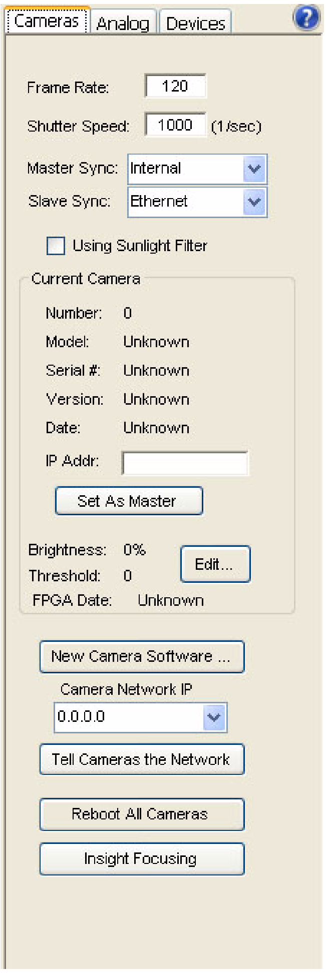
1. Choose **File > Load Setup...** from the Menu Bar and load a recent or sample capture.
2. Choose **System** from the Mode Buttons.
3. Choose the Cameras panel from the panel buttons if it is not already open.
4. Change the frame rate to the desired level.
5. Leave the Shutter Speed set to the default for normal data collection.
6. Click **Connect to Cameras** on the Real Time Dashboard if your cameras and connections are fully operational.

The system is now ready to go live with the **Run** button.

Cameras Panel

To connect to the cameras successfully, you must have the **[Eagle Support]** item in your **mac_lic.dat** file.

Figure 5-1. Cameras Panel


Cameras
Analog
Devices
Set As Master
Edit...
New Camera Software ...
Camera Network IP
Tell Cameras the Network
Reboot All Cameras
Insight Focusing

Frame Rate: 120

Shutter Speed: 1000 (1/sec)

Master Sync: Internal

Slave Sync: Ethernet

☐ Using Sunlight Filter

Current Camera

Number: 0

Model: Unknown

Serial #: Unknown

Version: Unknown

Date: Unknown

IP Addr:

Brightness: 0%

Threshold: 0

FPGA Date: Unknown

Camera Network IP: 0.0.0.0

Frame Rate

Sets the frame rate of the camera to any number ranging from 0.1 to the maximum frame rate. The number does not have to be an integer; it may be set to 59.97, for example.

Note: The maximum supported frame rate for the Motion Analysis digital camera system is 500 Hz. Please contact Motion Analysis Customer Support for information and technical advice for using frame rates higher than 500 Hz.

Shutter Speed

This sets the shutter speed of the camera ranging from 0 to 2000µs. This pulse is issued is in conjunction with the timing of the strobe (ring light) pulse. There are 1024 different levels of shutter speed control.

Hardware Sync

Master Sync

This sets the type of Frame Rate Synchronization used by the master camera.

Slave Sync

This sets how each slave camera is synchronized to the master camera. An Ethernet connection from camera to camera is the default. This is used on the legacy cameras for capturing at frame rates >500 fps.

Using Sunlight Filter

When activated, this feature eliminates large blobs (targets) and one-pixel blobs in the camera hardware caused by typical outside lighting. The tracking parameter “Max Horizontal Lines per Marker” gets set as the max size allowable target in horizontal pixels.

Genlocking Master Camera

This is selected when the master camera is synced to an external video source, either NTSC or PAL To enable the feature, you must have a license feature installed in your mac_lic.dat license file that looks something like the following line:

```
[Eagle Genlock]    9c3856f6    782cb125
```

Please contact support@motionanalysis.com if you need this license item.

To turn it ON, check the box called **Genlocking Master Camera** in the **System > Cameras** panel. When this is done, the Master Camera (which can be any of your cameras) must have an analog video signal (black burst or other signal) applied to the camera. This is done using the BNC connector of the 2 meter long Eagle Test Cable that came with the Motion Analysis system. It connects to the master camera using the AUX connector on the back of all the MAC digital cameras. Failure to connect the video signal to the Master camera will show up when you press the Run button. The slave cameras will send data but the Master camera will not.

This feature is available on all Motion Analysis digital cameras and can be set to any multiple of the NTSC or PAL frequencies that your mocap camera will allow. So you can capture at 59.94 (NTSC frequency) or 119.88 (2X NTSC) or 179.82 (3X NTSC) or higher if your motion capture camera will allow it. For NTSC genlock sync, you need to set the camera frame rate to 59.94 Hz (on the Cameras sup-panel). For PAL genlock sync, set the camera frame rate to 50 Hz (or 100 or 150 or 200 or so on). The slave cameras will follow the master camera without any extra wiring.

Current Camera Information

Displays the selected camera number and its corresponding IP address, software version number, along with the date and time the camera software was compiled.

Set as Master

Sets the selected camera as a master camera. A master camera generates synchronized pulses to the rest of the cameras within the system so that all camera shutters are opening and closing at the same rate.

Note: Only one master camera can be set for each system.

The master camera is set as follows:

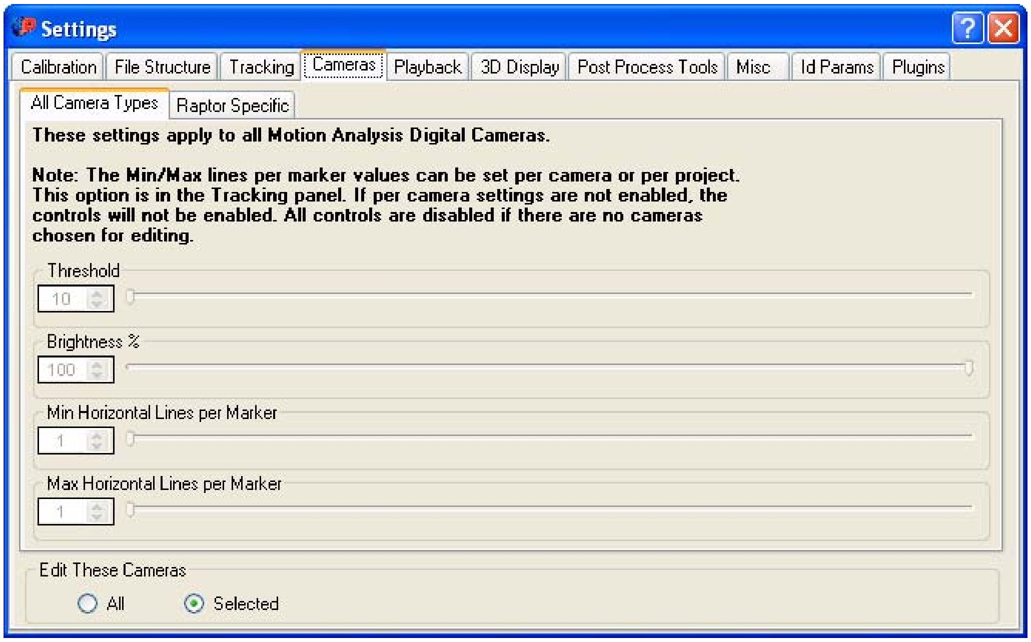
1. In the Real Time Dashboard, select the camera number button of the camera which you would like to set as a master camera.
2. Click on the **Set Master Camera** button.
3. If the camera is not turned on or working, select another camera in the Real Time Dashboard, and then press **Set Master Camera** again.
4. If you have an analog sub-system, the A-D sync cable must be connected from the master camera to the A-D Interconnect box.

Any camera may be designated as a master camera, but only one at a time.

Edit Button

This button opens the **Tools > Settings > Cameras** interface which features adjustment sliders for Threshold and Brightness settings, Min Horizontal Lines per Marker, and Max Horizontal Lines per Marker.

Figure 5-2. Edit Button (Tools > Settings > Cameras) Interface



These settings apply to all Motion Analysis Digital Cameras.

Note: The Min/Max lines per marker values can be set per camera or per project. This option is in the Tracking panel. If per camera settings are not enabled, the controls will not be enabled. All controls are disabled if there are no cameras chosen for editing.

Threshold: 10

Brightness %: 100

Min Horizontal Lines per Marker: 1

Max Horizontal Lines per Marker: 1

Edit These Cameras: ○ All ● Selected

Changing the Camera's IP Address

You can change the IP address in this box for any camera at any time. You need to make sure that you do not use duplicate numbers though. It is recommended that you use the same IP address number scheme as used when the cameras are first shipped (10.1.1.xxx). The last three digits should be any number between 1 and 250. In the event that your local area network is set to a 10.1.1.xxx IP scheme, you can also use 10.1.2.xxx for the camera network (Eagle Host computer, EagleHubs, cameras, etc.).

Loading New Camera Software

Note: Raptor camera systems will update all of the cameras all at once when loading the new camera software. Eagle4, Eagle, and Hawk cameras must have the new software loaded one camera at a time.

Loading New Eagle/ Hawk Camera Software...

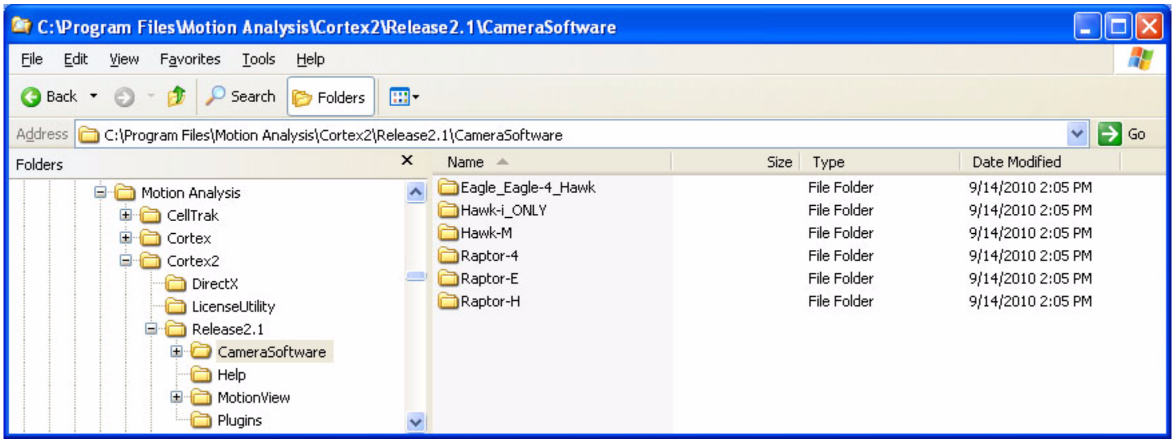
Note: The software loaded into the camera must be of the form **rom_filename_date.bin** for non Raptor cameras and **filename+date.cam** for Raptor series and Hawk-M cameras. The specific date in the file name may vary.

Note: Hawk-i cameras require a different version of the **rom.bin** software from the other digital cameras. Loading of incorrect software may cause your Hawk-i camera to cease functioning. The **rom.bin** file for the Hawk-i cameras is found in a folder of its own, under the Camera Software directory.

Install the new software as follows:

1. Obtain the latest camera software file from the Camera Software folder associated with this **Cortex** software release.
2. Copy the **rom_(date).bin** file into the following directory: **C:\Program Files\Motion Analysis\Cortex2\Release 2.1\Camera Software**

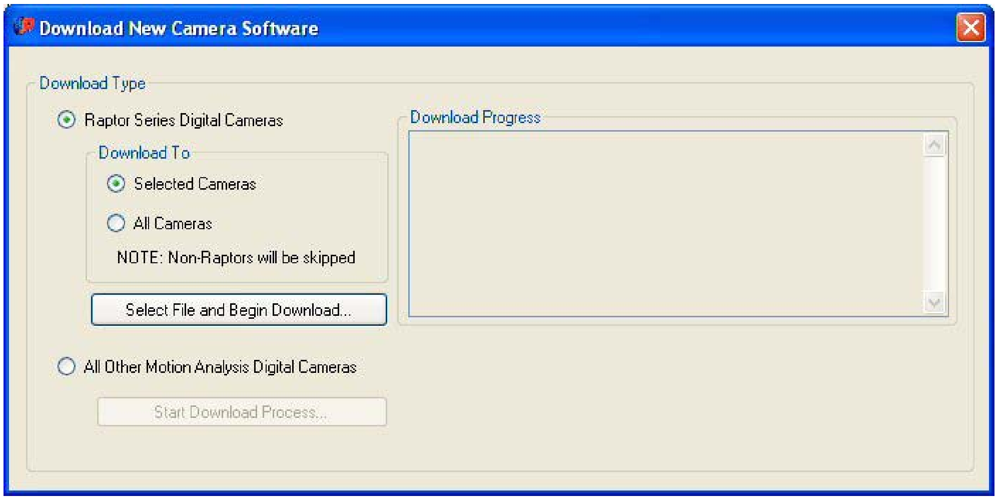
Figure 5-3. Camera Software Directory


C:\Program Files\Motion Analysis\Cortex2\Release2.1\CameraSoftware
File
Edit
View
Favorites
Tools
Help
Back
Search
Folders
Address
C:\Program Files\Motion Analysis\Cortex2\Release2.1\CameraSoftware
Go
Folders
Motion Analysis
CellTrak
Cortex
Cortex2
DirectX
LicenseUtility
Release2.1
CameraSoftware
Help
MotionView
Plugins

Name	Size	Type	Date Modified
Eagle_Eagle-4_Hawk		File Folder	9/14/2010 2:05 PM
Hawk-i_ONLY		File Folder	9/14/2010 2:05 PM
Hawk-M		File Folder	9/14/2010 2:05 PM
Raptor-4		File Folder	9/14/2010 2:05 PM
Raptor-E		File Folder	9/14/2010 2:05 PM
Raptor-H		File Folder	9/14/2010 2:05 PM

3. Return to the Calibration panel in the **Cortex** user interface.
4. Select the camera (on the Real Time Dashboard) you wish to load the new **rom_(date).bin** software into and click on the **New Camera Software...** button in the Cameras panel.

Figure 5-4. Download New Camera Software Dialog



Download New Camera Software

Download Type

● Raptor Series Digital Cameras

Download To

● Selected Cameras

○ All Cameras

NOTE: Non-Raptors will be skipped

Select File and Begin Download...

○ All Other Motion Analysis Digital Cameras

Start Download Process...

Download Progress

5. Manually type in the Unit's IP address prior to clicking on the **Download** button.
6. Navigate to the **Camera Software** directory with the **[..]** and select **rom_(date).bin**.
7. Click **Download** and wait about two minutes for the Writing to Flash operation to finish.

Note: If the message "Send Failed" appears, ignore and press **Download** again.

8. Once the software has been loaded, the cameras may blink oddly. After this, you will need to reboot all the cameras by cycling the power on the EagleHub.
9. Run the **Cortex** software and click on **Connect to Cameras**.
10. Finally, check all cameras for the new software version number.

Loading New Raptor Camera Software...

The following example is for Raptor-E cameras. You can adjust this as needed for different Raptor or Hawk-M cameras.

1. Copy the file **Raptor-E_Jun30-2010.cam** into the **C:\Program Files\Motion Analysis\Cortex2\Release2.X.X.XXX\CameraSoftware\Raptor-E** directory
2. Launch Cortex and select **Connect to Cameras**.
3. In the **System > Cameras** panel, click on the **New Camera Software…** button.
4. Select the **Raptor Series Digital Cameras** and the **All Cameras** radio buttons. Then click on the **Select File and Begin Download…** button (refer to Figure 5-4).
5. Press the **OK** button in the Raptor Download Instructions box.
6. Open the **Raptor-E_Jun30-2010.cam** file located in the **\CameraSoftware\Raptor-E** folder.

The Download Progress window in the Download New Camera Software box will show the status of each camera.

7. After the firmware has been downloaded on each camera, a message saying "File download completed [X.X seconds], now writing flash…" will appear in the Download Progress window.
8. Once the firmware has been installed on each camera, a message saying "Successfully wrote new image into flash." will appear in the Download Progress window and the ringlight on each camera will turn off. Also, each camera will have a red "**R**" showing on the camera display board.

   DO NOT touch the cameras until the **R** appears on the display board.
9. Once all cameras have **R** on their display boards, power cycle (turn on/off power) each power hub.
10. Once all cameras have rebooted, select **Connect To Cameras**. The camera firmware date on each camera can be checked by going to **System > Cameras** and verifying the date is **June 30 2010**.

Do I need to update camera software?

You can continue to use the same **rom.bin** software. Reasons to upgrade to the new camera software include:

1. Displays camera numbers greater than 99.
2. Mixed camera environment with all cameras (including Eagle, Hawk, and Raptor).

Old Camera, New Camera Compatibility Issues

Cameras with different revisions of the CPU board installed may exhibit problems with different versions of the rom.bin software.

How to tell which cameras have the OLD CPU board and which cameras have the NEW CPU Board is easy:

- ALL Eagle, Eagle4, and Hawk Cameras with the SILVER backplate (where the connectors are) have the newer CPU boards (CE approved) and require the newer camera software, dated **May 9, 2005** or later.
- Cameras with the BLACK backplate have the older CPU card (non CE approved) can use either the NEWER or the OLDER rom.bin software.

Note: Raptor Camera software is included with the **Cortex** releases (see Figure 5-3). Contact support@motionanalysis.com if you have any questions about updating the camera software in your MAC digital cameras.

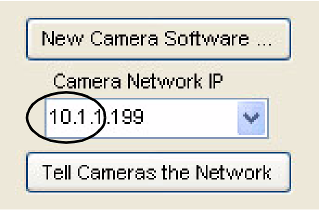
Dedicated Interface for Cameras

Allows you to input the IP address for the network interface card (NIC) of the host computer. This is the IP address for the NIC that is connected to the Eagle cameras. There must be a dedicated NIC for this purpose. Other connections to local area networks (LAN) must be done on a different NIC to avoid network traffic on the camera network and to keep the Motion Analysis camera system working properly.

Tell Cameras the Network

This resets all the cameras in the network to the first three digits of the camera network IP address.

Figure 5-5. First Three Digits of Camera IP Network Address



Reboot All Cameras

Reboots the cameras (does not cycle the power). This is used when changing the camera's IP addresses. Note that the camera and software will not recognize the change in IP address until the camera has been rebooted. If this does not work, you can cycle the power of the camera by unplugging it or turning off the camera's power hub. Wait for ten seconds before turning the power hub back on.

Insight Focusing

This button starts the Insight Focusing procedure. For complete information, refer to "Insight Focusing for Raptor Series Cameras" on page 3-28.

Camera Display Codes

The digital camera displays indicate which mode the cameras are operating.

Note: The smaller (Hawk-M) cameras do not have the display feature.

Note: Displays may vary for each camera type.

Table 5-1. Camera Display Codes

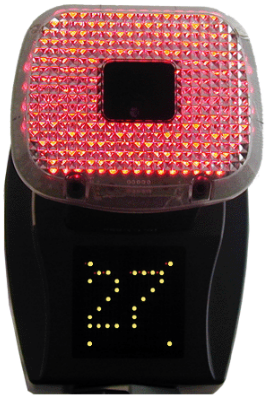
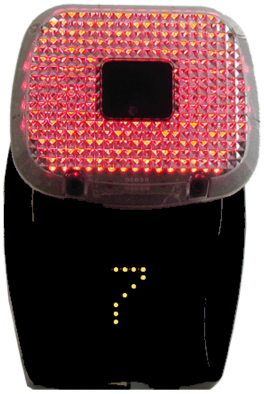
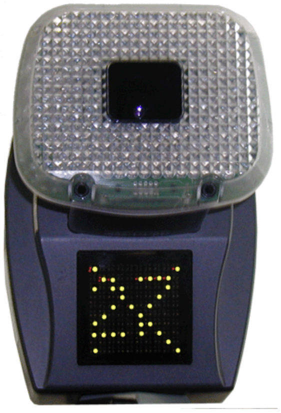
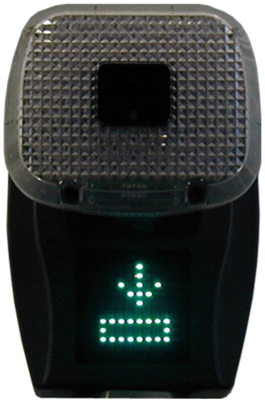
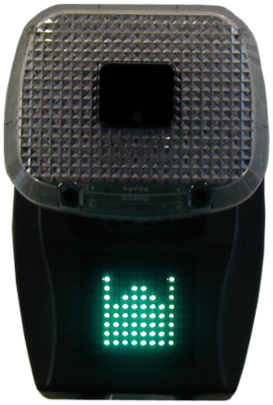
Code	Image	Description
Master Camera		This display code, with the active LEDs in the four corners, indicates that the camera has been set as a master camera. The ringlights are ON, which indicates that **Connect To Cameras** on the **Cortex** interface is active. Yellow (Red and Green ON) numbering indicates that the camera is in an idle state (powered up but not connected). Red number displays indicate that the camera is either disabled, out of sync, or that there is a hardware problem within the camera.
Standard Camera		This display code has no active LEDs other than those set for the number display LEDs. This indicates a standard operating camera.
Camera Ready for rom.bin Download		This display code, with the active LEDs in a slash through the display number, indicates that the Eagle camera is ready to accept a new **rom_date.bin** file. This display code will be go away after the new software has been installed and the camera is rebooted.

Table 5-1. Camera Display Codes

Code	Image	Description
Press Download		This display code, with active LEDs in an arrow and rectangle pattern, indicate that the Download button, in the Download FTP window, is ready to be pressed.
Rom.bin Download in Progress		This display code indicates the progress of the download process. The number of activated LEDs will increase as the download process nears completion.

Creating and Clearing Masks

Masks are rectangular regions in the 2D View that you designate to receive no marker information. Masks allow you to block out fixed light sources that cannot be physically removed from a camera's view. Masks are created on the 2D Display by clicking and dragging the middle mouse button and appear as hatched regions.

Masks can be cleared by using the right mouse pop-up menu item in the 2D Display and choosing either **Delete Mask** or **Delete All Masks**. Note that you can use masks after the VC data has been collected by disconnecting from the cameras, creating the mask, and then loading or selecting the raw files. This applies to the calibration files (CalSeed and CalWand) as well.

Hardware Masks

For Raptor-4, Raptor-E, Eagle-4, and Eagle cameras, the first 12 masks are hardware masks. Hardware masks are created in the camera, and the marker edges do not get sent to the **Cortex** software. Masks 13+ become software masks: the edge data is sent to he **Cortex** software and ignored (no centroid is calculated). Hardware masking is generally preferred as it reduces the Ethernet traffic and reduces the size of the VC files.

Going Live

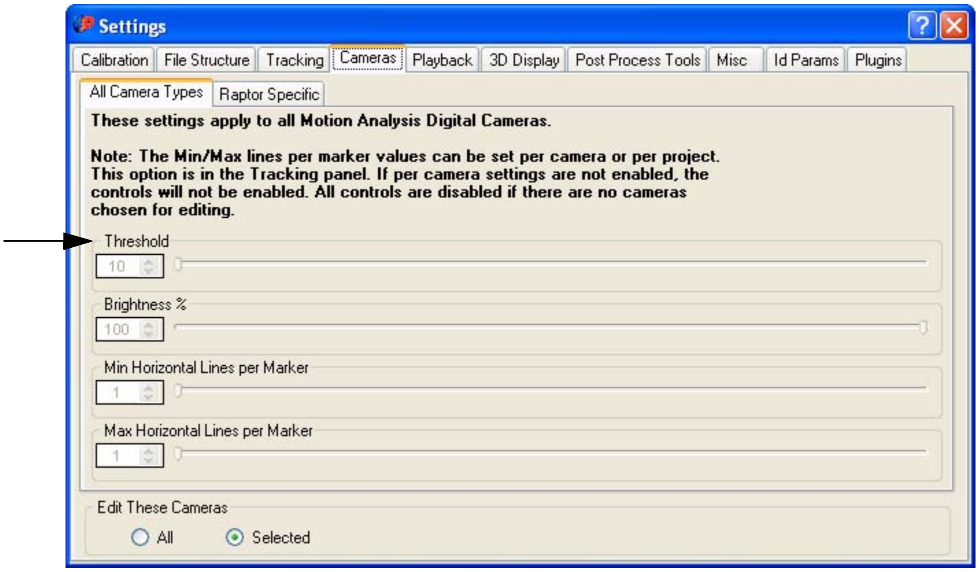
After having configured the software to the system and connected **Cortex** to the cameras:

1. Place the calibration L-frame on the floor in the capture volume. The orientation of the calibration L-frame determines the directions of your global X, Y, and Z axes.
2. Press **F2** on the keyboard to open the 2D Display. The view seen by one or several cameras will be displayed. To select multiple cameras, press **Shift** + click or **Ctrl** + click on any of the camera buttons on the Real Time Dashboard or click **All On**.
3. Click the **Run** button on the Real Time Dashboard.

Adjusting Thresholds

1. Choose **Tools > Settings > Cameras** from the Menu Bar.
2. Slide the Threshold slider on the floating Thresholds control until the markers on the floor appear on the screen.

Figure 5-6. Threshold Slider


Settings
Calibration
File Structure
Tracking
Cameras
Playback
3D Display
Post Process Tools
Misc
Id Params
Plugins
All Camera Types
Raptor Specific

These settings apply to all Motion Analysis Digital Cameras.

Note: The Min/Max lines per marker values can be set per camera or per project. This option is in the Tracking panel. If per camera settings are not enabled, the controls will not be enabled. All controls are disabled if there are no cameras chosen for editing.

Threshold: 10

Brightness %: 100

Min Horizontal Lines per Marker: 1

Max Horizontal Lines per Marker: 1

Edit These Cameras

○ All ● Selected

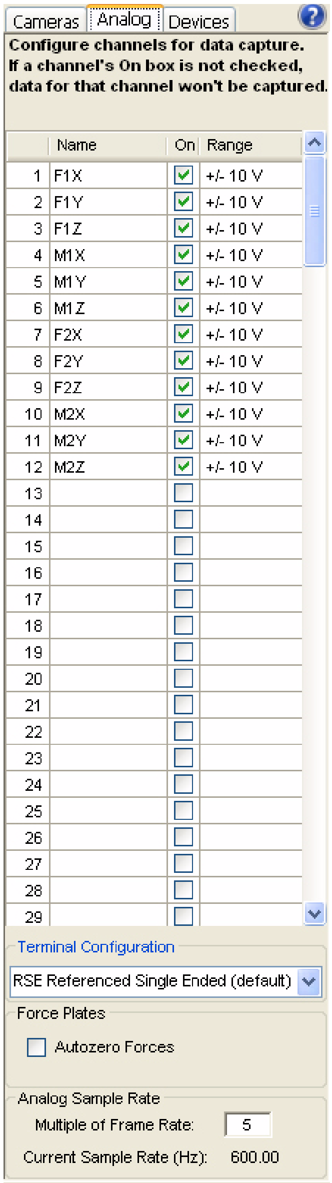
3. Select a camera.
4. If you are not seeing any blobs on the screen, choose **Motion Capture** from the Mode Buttons. Then in the Tracking Panel, set the Min. Horizontal Lines per Marker to **2** and Max Horizontal Lines per Marker to **100**.
5. Mask out any unwanted light sources by creating a mask with the middle mouse button held down. Delete masks by clicking on a mask and pressing **Delete** on the keyboard or right-clicking in the 2D Display and selecting **Delete Mask**.
6. Repeat Steps 4 through 5 for all cameras.

Analog Panel

For users who have integrated force plates into their motion capture system, you will need to configure the EMG or other analog source signals for the analog signals to be collected properly. This is done by following these steps.

1. Choose the **System > Analog** panel.

Figure 5-7. Analog Panel



Configure channels for data capture.
If a channel's On box is not checked, data for that channel won't be captured.

	Name	On	Range
1	F1X	☑	+/- 10 V
2	F1Y	☑	+/- 10 V
3	F1Z	☑	+/- 10 V
4	M1X	☑	+/- 10 V
5	M1Y	☑	+/- 10 V
6	M1Z	☑	+/- 10 V
7	F2X	☑	+/- 10 V
8	F2Y	☑	+/- 10 V
9	F2Z	☑	+/- 10 V
10	M2X	☑	+/- 10 V
11	M2Y	☑	+/- 10 V
12	M2Z	☑	+/- 10 V
13		☐	
14		☐	
15		☐	
16		☐	
17		☐	
18		☐	
19		☐	
20		☐	
21		☐	
22		☐	
23		☐	
24		☐	
25		☐	
26		☐	
27		☐	
28		☐	
29		☐	

Terminal Configuration
RSE Referenced Single Ended (default)

Force Plates
☐ Autozero Forces

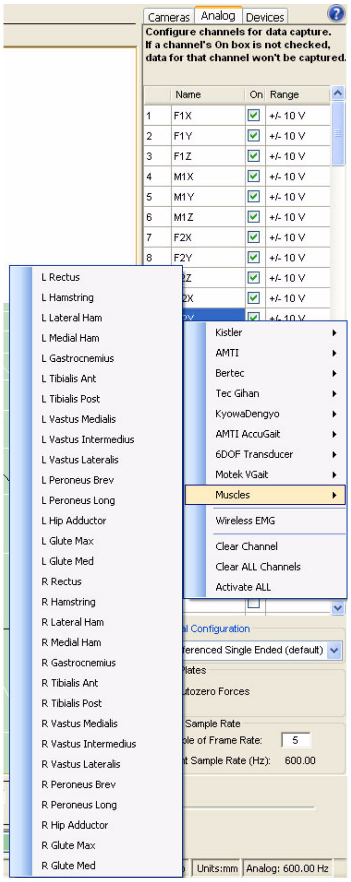
Analog Sample Rate
Multiple of Frame Rate: 5
Current Sample Rate (Hz): 600.00

2. To open a list of force plate names, right-click anywhere on the Analog panel grid and choose **Channel Type Names** from the pop-up menu. The built in names include Kistler, AMTI, Bertec and Muscles.

3. To edit a channel’s name, left-click in its row in the Name column.
4. Left-click on the arrow that appears in the cell and select a name. Alternatively, you can simply left-click in the cell and type in a name directly.
5. Left-click in the channel’s row in the Active column if you wish to make it active. You can also click in the Active column’s title cell or right-click on the Analog panel grid and select **Activate All Named Channels**. Both actions activate all named channels.
6. Left-click in the channel’s row in the Range column and click on the arrow to select a voltage range. The range must match the output of your analog device.
7. Select the correct sample rate for your system from the Sample per Second drop list at the bottom of the panel.
8. To select EMG muscle names, right-click in the Analog panel and select **Muscles.** For any particular analog channel number, left-click in the Name column and scroll through the drop-down menu for the EMG muscle name you want (see Figure 5-8).

Note: The Force Plate and EMG muscle names are consistent with the names used in the **Orthotrak** Gait Analysis and KinTrak software from Motion Analysis.

Figure 5-8. EMG Muscle Name Selection


Cameras
Analog
Devices
L Rectus
L Hamstring
L Lateral Ham
L Medial Ham
L Gastrocnemius
L Tibialis Ant
L Tibialis Post
L Vastus Medialis
L Vastus Intermedius
L Vastus Lateralis
L Peroneus Brev
L Peroneus Long
L Hip Adductor
L Glute Max
L Glute Med
R Rectus
R Hamstring
R Lateral Ham
R Medial Ham
R Gastrocnemius
R Tibialis Ant
R Tibialis Post
R Vastus Medialis
R Vastus Intermedius
R Vastus Lateralis
R Peroneus Brev
R Peroneus Long
R Hip Adductor
R Glute Max
R Glute Med
Kistler
AMTI
Bertec
Tec Gihan
KyowaDengyo
AMTI AccuGait
6DOF Transducer
Motek VGait
Muscles
Wireless EMG
Clear Channel
Clear ALL Channels
Activate ALL
l Configuration
Plates
utozero Forces

Configure channels for data capture. If a channel's On box is not checked, data for that channel won't be captured.

	Name	On	Range
1	F1X	☑	+/- 10 V
2	F1Y	☑	+/- 10 V
3	F1Z	☑	+/- 10 V
4	M1X	☑	+/- 10 V
5	M1Y	☑	+/- 10 V
6	M1Z	☑	+/- 10 V
7	F2X	☑	+/- 10 V
8	F2Y	☑	+/- 10 V
	Z	☑	+/- 10 V
	X	☑	+/- 10 V

ferenced Single Ended (default)

Sample Rate

ple of Frame Rate: 5

t Sample Rate (Hz): 600.00

Units:mm Analog: 600.00 Hz

9. To save the entries in the Analog panel, choose **File > Save Setup** from the Menu Bar.
10. If you would like to give the file a new name or save it to a different directory, choose **File > Save Setup As...**.

Shifting Selected Analog Data

This series of functions is used to correct the time-shift-delay in certain telemetered EMG channels. These are introduced by Noraxon EMG units (model 2400 and later), which have a 15ms delay in their signal transmission protocols. As a result, the EMG signals in multi-source (EMG and force plates) analog data collected by the Motion Analysis system become non-synchronous with the motion data.

Cortex allows the user to time shift the EMG data in the analog channels using the following steps:

1. Load a Capture into Post Processing.
2. Select **Data Views > Analog Graphs**.
3. In the Analog Graphs display, right-click and select the **Shift the Data** option.
4. In the Visible Channels dialog, select only the channels you want shifted (typically the EMG data).
5. In the Shift the Data dialog, select the **Selected Channels** option.
6. Set the value for the "Shift the data this number of samples". This can be calculated by the following formula:

   # of samples to shift = (Analog Sample Rate) x (Time Delay)

Example

For an analog sampling rate of 1200 samples/second and a time delay of 15 ms (15 x 10^{-3} seconds) the calculation would be:

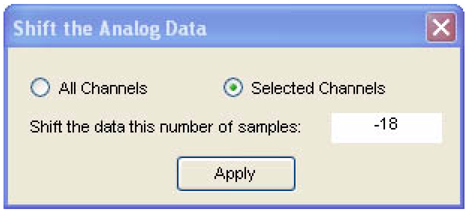
# of samples to shift = (1200 samples/sec) x (15 x 10^{-3} sec) = 18 samples

1. To input this frame-shift correctly, enter the number as negative value (–18).

   Negative values indicate a shift to the left (decreasing the delay), positive numbers indicate a shift to the right (increasing the delay).

2. To change the entered value from red to black, press **Enter**.
3. Click on **Apply**. When it prompts you with "Would you like to rewrite the analog file?", select **Yes**.

Figure 5-9. Shift the Analog Data Dialog Box



○ All Channels ● Selected Channels

Shift the data this number of samples: -18

Maximum Analog Acquisition Rate

The maximum analog rate is determined by one of the following considerations:

1. The maximum throughput of the National Instruments (NI) A-D product
2. The video sample rate multiplied by 255

The NI USB-6218 A-D unit, which is often supplied with Motion Analysis systems, has a maximum throughput of 250,000 samples/sec (per unit). So two units with 64 channels would have the ability to collect up to 500,000 samples/sec. Either way, it is 250,000/32 channels or about 7500 samples/sec per channel with all channels collecting data. If you cut down to 16 channels, you can have 15,000 samples/sec per channel. You can also connect up to 6 devices and use only 16 channels from each device.

For increased speed, use the faster USB-6259 A-D unit from NI. This unit is 32 channels, 16 bits (same as USB-6218), but has a throughput of 1.25 Million samples/sec or 5-times greater than the throughput of the USB-6218.

The video sample rate multiplied by 255 limitation comes into play mainly if a slow mocap video rate (e.g. 60 Hz) is being used. The max analog rate in this case is 15,300 (60 X 255). Under normal conditions, customers using higher analog rates would also be using higher mocap video rates. With a mocap video rate of 200 Hz, the max analog setting is 200 multiplied by 255 or 51,000 Hz. Note that you can do this with the USB-6218 with fewer channels turned on: 250,000/ 51,000 = 4.9 (or 4 channels).

Terminal Configuration

This sets the type of analog input configuration used in the capture session. for more information, go to the National Instruments website: http://zone.ni.com/devzone/cda/tut/p/id/3394

The analog inputs can be configured in one of three modes: RSE, NRSE, and Differential (per the capabilities of the A/D device from National Instruments).

RSE (Referenced Single Ended)

This provides a single common ground for all analog channels. This is used for smaller analog systems (small number of devices).

NRSE (Non-Referenced Single Ended)

This provides a single common ground that uses the AI Sense wire. This is used for analog systems with a larger number of devices.

Differential

This provides a two-wire (+ and -) for each analog channel which halves the number of channels. This is good for low-level signals and noise reduction. Consult NI.com for more details on this feature or contact Motion Analysis Customer Support (support@motionanalysis.com).

Forceplates—Autozero Forces

The Autozero forces do not change the raw data values. If there is a drift or an offset in the analog voltage, it is recorded in the analog binary (.anb) file. The Cortex software uses "Autozero forces" in the following places:

1. In the 3D view window that shows the force plate, forces, and stick figure
2. In the **Tools > Force Plate Forces...** box that shows the numbers
3. In the **File > Export > Export Forces File...** item whereby the calibrated forces are written to the ASCII trialN.forces file

Analog Sample Rate

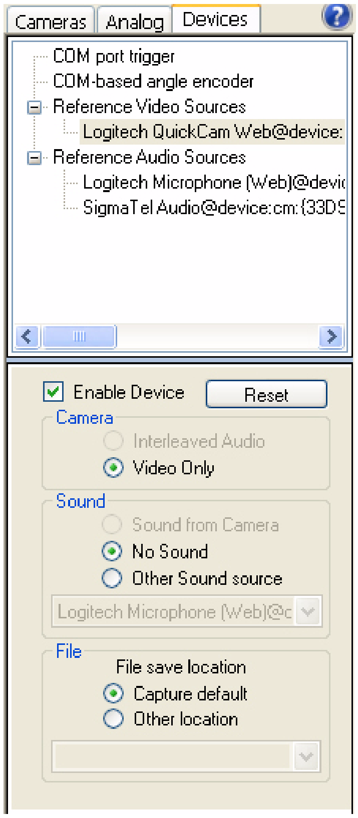
This is the current sample rate (Hz) of the analog signal in reference to the capture frame rate of the cameras. This can be adjusted by changing the-Multiple of Frame Rate value. This setting is typically set to a value of 10.

Analog Sample Rate = Multiple of Frame Rate x Camera Frame Rate

Devices Panel

The Devices panel provides a listing of the hardware devices that are currently used in the operation of the **Cortex** software (e.g. color digital video cameras, external trigger switch, etc.). This panel also provides access to enabling/disabling the general features of these devices. By clicking on the device, you can control the it through the interface design of the original manufacturer.

Figure 5-10. Devices Panel with Example Reference Video Source Interface



COM port trigger
COM-based angle encoder
Reference Video Sources
  Logitech QuickCam Web@device:
Reference Audio Sources
  Logitech Microphone (Web)@devic
  SigmaTel Audio@device:cm:{33DS

☑ Enable Device

Camera
○ Interleaved Audio
● Video Only

Sound
○ Sound from Camera
● No Sound
○ Other Sound source
Logitech Microphone (Web)@c

File
File save location
● Capture default
○ Other location

Chapter 6 Calibration Tab

Topic	Page
Calibrating Your System	6-1
What is the Square and Wand Calibration?	6-2
Calibrate Panel	6-3
Calibration Files	6-18
Calibration from Previously Collected Files	6-19
Extending the Seed Calibration	6-20
Post Processing Square and Wand Data	6-21

Calibrating Your System

A new calibration must be performed whenever:

- camera positions have changed
- the coordinate system orientation has changed
- the units of measure have changed

It is imperative to complete an accurate calibration in order to collect high quality motion data.

Calibrating your system is a two step process. First, the seed calibration is done by employing the calibration L-frame. The exact positions of these markers must be known. Next, a wand with precisely located markers is waved around throughout the capture volume by somebody wearing no reflective material. Wand calibration ensures that a direct measurement of an object of known size has been made by all cameras throughout the entire capture volume.

This process locates the exact positions of your cameras and accounts for any geometric distortion the camera lenses may have, as well as accurately measuring the camera lens focal-lengths. The importance of this information is so great that a new calibration must be completed if a camera is moved or even accidentally bumped.

Calwand.vc1...N Files

Calwand.vc1...N files (one file for each camera) get written when you press the "Collect and Calibrate" button in the "Calibrate with Wand" box and you are also connected to the cameras. If you are not connected to the cameras, the button will read "Calbrate" and you can process the data in the simulated realtime mode as above. The software starts with the current state of the calibration (which is normally the results of the seed calibration, but can be otherwise) and refines the calibration. The calibration includes the exact location and orientation of each camera with respect to the origin, the lens distortion parameters for each camera, and other details about the cameras. When the user accepts the calibration the result is automatically saved to the file "SystemSetup.cal". This "SystemSetup.cal" file is automatically loaded each time you start **Cortex** so you always start with the most recent calibration already loaded.

TrialN.cal

Every time you collect a trial in the **Motion Capture > Output** panel, the system writes out the current calibration to a file that has the same name as your trial name, but with a .cal extension. This file is the default calibration that will be loaded when you load a capture (you must also have the "Load Calibration" checkbox active).

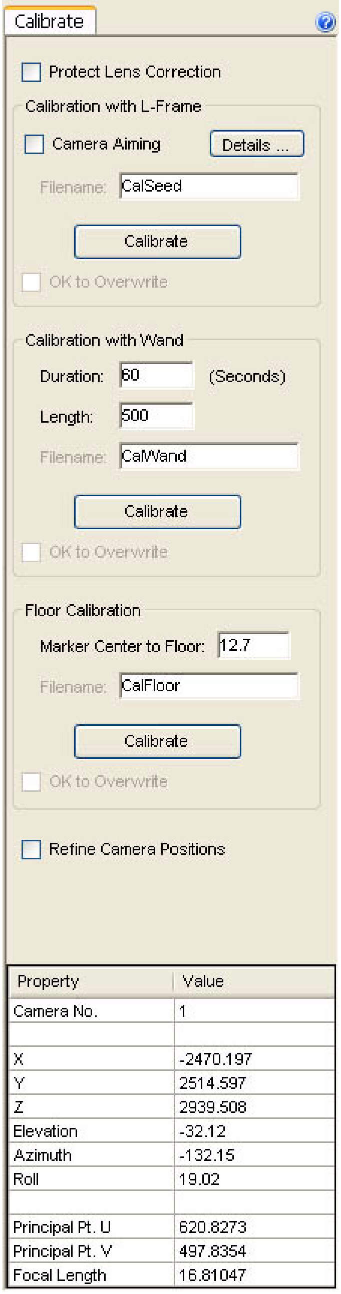
What is the Square and Wand Calibration?

In **Cortex**, a four-point square and wand calibration has proven to be very robust and is extremely accurate. This method requires only four markers on the L-frame and three markers on the wand.

Note: If using an L-frame, orient your markers in the same directions as illustrated. Care should also be taken in placing the 4 points on the floor as this determines the global axes and the orientation of the volume displayed in **Cortex**. The points on the 3-point axis must be in a straight line and the spacing of point 2 must be close to 1/3 of the distance between points 1 and 3.

Calibrate Panel

Figure 6-1. Calibration > Calibrate Panel



☐ Protect Lens Correction

Calibration with L-Frame

☐ Camera Aiming

Filename: CalSeed

☐ OK to Overwrite

Calibration with Wand

Duration: 60 (Seconds)

Length: 500

Filename: CalWand

☐ OK to Overwrite

Floor Calibration

Marker Center to Floor: 12.7

Filename: CalFloor

☐ OK to Overwrite

☐ Refine Camera Positions

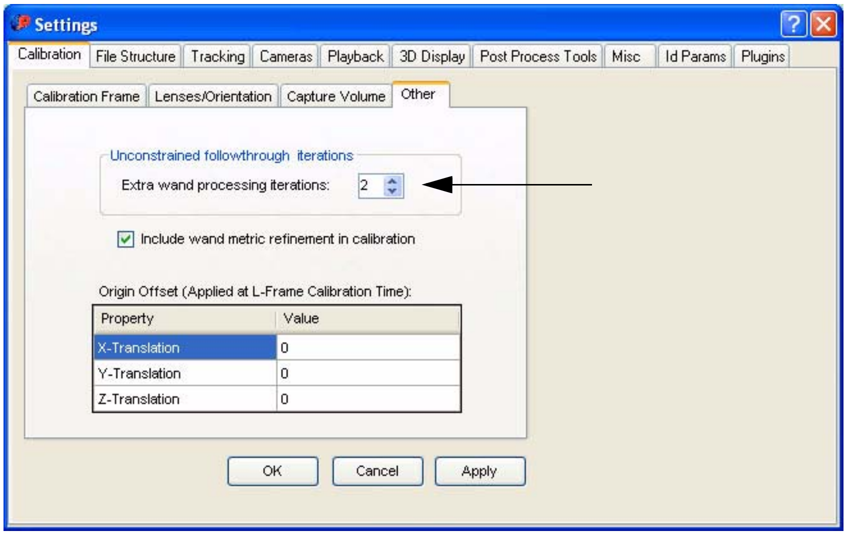
Property	Value
Camera No.	1
X	-2470.197
Y	2514.597
Z	2939.508
Elevation	-32.12
Azimuth	-132.15
Roll	19.02
Principal Pt. U	620.8273
Principal Pt. V	497.8354
Focal Length	16.81047

Protect Lens Correction

This locks the lens corrections coefficients for all cameras as saved in your capture file. Once you have set your lenses' focus and zoom factor, the lens distortion maps should not change and they need not be calculated with each wand calibration. With **Protect Lens Correction** checked, the wand calibration will converge more quickly. So if you do not change the lenses, it is a good idea to leave this box checked for all your calibrations AFTER you have completed a good wand coverage and good wand calibration. The results of the successful wand calibration are stored in your capture file and your System Calibration file. The System Calibration file can be saved after each wand calibration. It is the default calibration that is used when your launch the **Cortex** software.

For a very accurate calibration, go to the **Tools > Settings > Calibration > Other** tab and change the **Extra wand processing iterations** value to **2** before collecting or processing the wand data.

Figure 6-2. Tools > Settings > Calibration > Other Tab



Unconstrained followthrough iterations

Extra wand processing iterations: 2

☑ Include wand metric refinement in calibration

Origin Offset (Applied at L-Frame Calibration Time):

Property	Value
X-Translation	0
Y-Translation	0
Z-Translation	0

The above procedure uses the first Wand Calibration to determine the Lens Distortion mappings and uses the second processing of the Wand calibration to refine the calibration. Subsequent wand calibrations can be run like steps 3 and 4 if you do not change the lens settings.

Calibration with L-Frame

Camera Aiming

This optional check-box has two functions:

1. It is used to give a real-time view for positioning the cameras. This is done in conjunction with using the Cam Field-Of-View function (3D Display Show Properties). The cameras are positioned based on the 3D volume specified and you can zoom in and out to see the change in the field-of-view.

2. It is also used to make sure each camera can see all the markers of the calibration L-frame.

Note: If Camera Aiming is checked and Run is selected, the calibration will be recalculated and previous calibration results will be lost.

Details... Button (Calibration Settings Window Tabs)

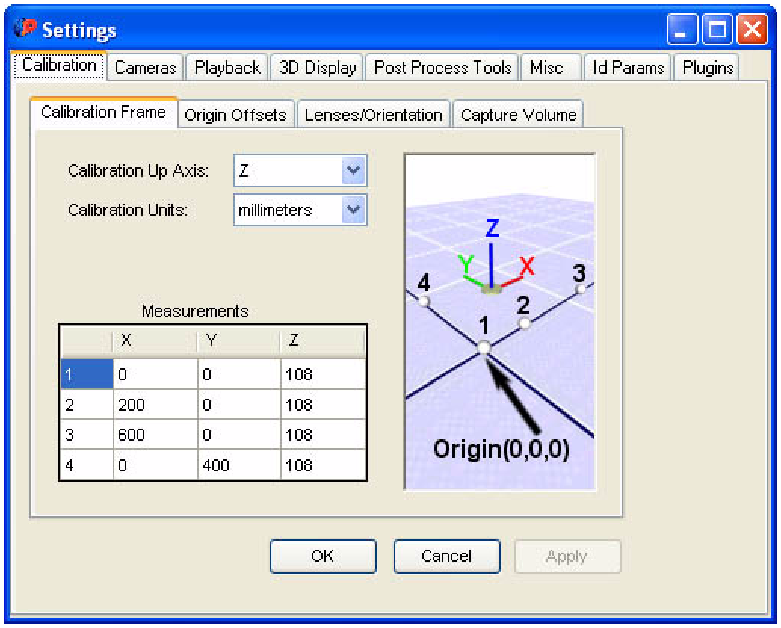
Click the **Details** button, located in the upper-right corner, in the Calibration panel.

The tabs for the calibration settings window, shown in Figure 6-3 on page 6-5, are defined as follows.

Calibration Frame Tab

Where you enter the measurements of the calibration L-frame. You can make your own calibration L-frame by placing four markers on the floor and measuring their locations with a tape measure. Measurements should be within 1 mm. See Figure 6-3 for reference alignment using the Z-up calibration method. Selecting a different calibration up-axis will show the correct view on how to set up your calibration L-frame.

Figure 6-3. Calibration Frame Tab


Settings
Calibration
Cameras
Playback
3D Display
Post Process Tools
Misc
Id Params
Plugins
Calibration Frame
Origin Offsets
Lenses/Orientation
Capture Volume
Z
Y
X
4
3
2
1
Origin(0,0,0)
OK
Cancel
Apply

Calibration Up Axis: Z

Calibration Units: millimeters

Measurements

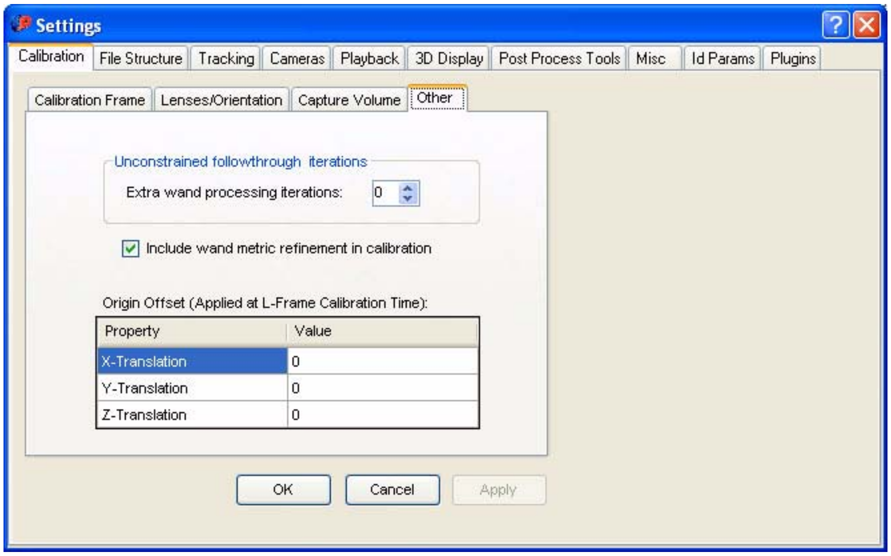
	X	Y	Z
1	0	0	108
2	200	0	108
3	600	0	108
4	0	400	108

Origin Offsets Tab

This allows for translation and rotation from the origin. The calibration L-frame may then be positioned anywhere in the motion capture area. This is useful for two possible reasons:

1. All cameras do not see the calibration frame, but you want to use it to position the cameras. In this case, you can move the calibration frame to where it can be seen and enter the Origin Offsets measured from the true origin to the (temporary) location of the calibration frame.
2. You want a different location for an origin for any reason.

Figure 6-4. Origin Offsets Tab


Settings
Calibration
File Structure
Tracking
Cameras
Playback
3D Display
Post Process Tools
Misc
Id Params
Plugins
Calibration Frame
Lenses/Orientation
Capture Volume
Other
Unconstrained followthrough iterations
OK
Cancel
Apply

Extra wand processing iterations: 0

☑ Include wand metric refinement in calibration

Origin Offset (Applied at L-Frame Calibration Time):

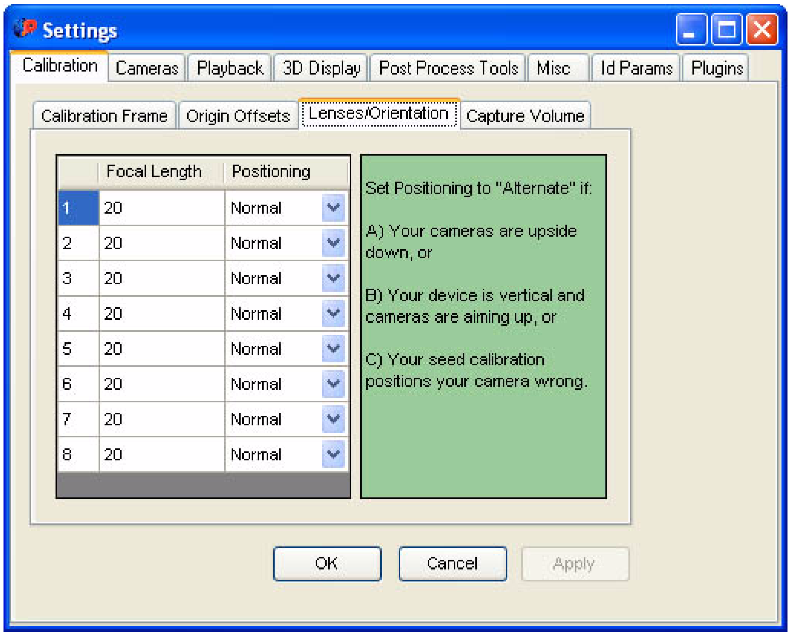
Property	Value
X-Translation	0
Y-Translation	0
Z-Translation	0

Lenses/Orientation Tab

This tab is used to set the focal length and positions of each camera as used at the start of the wand calibration procedure. If you use the **Camera Aiming** check box in the Calibrate panel to position and orient your camera, the focal length entries should be nominally correct (e.g. 6 for 6 mm lenses). In the Camera Aiming and Calibration with Square functions, the **Show > Show Camera Field of View** cone is determined only by what you put in this table. After the wand calibration, the actual focal length of the lens is calculated exactly and can be stored in your capture file.

Note: The **Calibrate Wand** option calculates the actual focal lengths, but does not update the table.

Figure 6-5. Lenses/Orientation Tab


Settings
Calibration
Cameras
Playback
3D Display
Post Process Tools
Misc
Id Params
Plugins
Calibration Frame
Origin Offsets
Lenses/Orientation
Capture Volume
OK
Cancel
Apply

	Focal Length	Positioning
1	20	Normal
2	20	Normal
3	20	Normal
4	20	Normal
5	20	Normal
6	20	Normal
7	20	Normal
8	20	Normal

Set Positioning to "Alternate" if:

A) Your cameras are upside down, or

B) Your device is vertical and cameras are aiming up, or

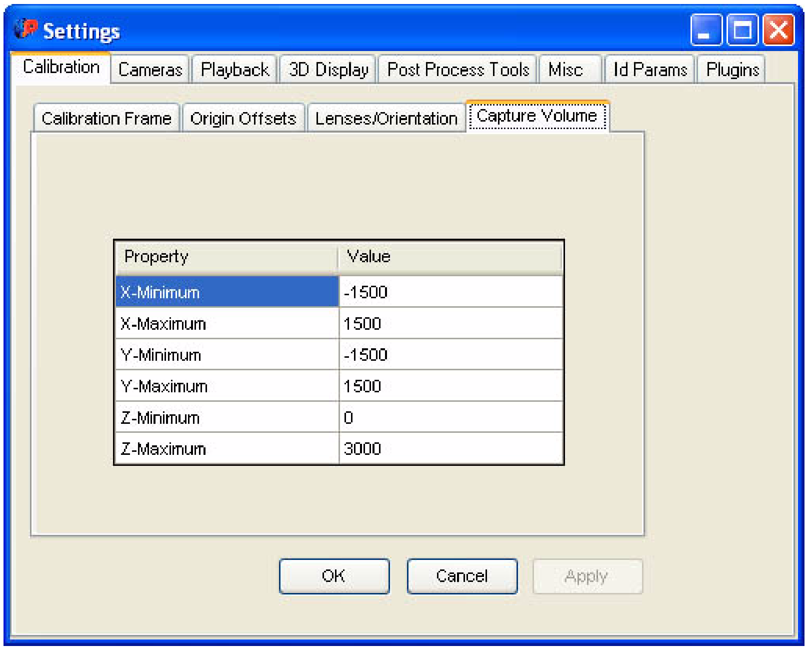
C) Your seed calibration positions your camera wrong.

Capture Volume Tab

This displays the rectangular capture volume according to your measurements and helps to provide a visual reference of the volume to the operator. It does not affect the tracked data in any manner. It is for display purposes only in the 3D view.

In the **Plugins > X** panel, the Delete Outside Volume feature will delete any marker data outside of the capture volume.

Figure 6-6. Capture Volume Tab



Property	Value
X-Minimum	-1500
X-Maximum	1500
Y-Minimum	-1500
Y-Maximum	1500
Z-Minimum	0
Z-Maximum	3000

Square (Seed) Calibration of Cameras

Selecting **Tools > Settings > Calibration > Calibration Frame Tab** (or **Calibration Panel > Details),** will bring up a window as shown in Figure 6-3 on page 6-5. The calibration L-frame should be laid out on the floor exactly as is in this figure. This can be done with four separate loose markers, or it can be done using the wand and a single loose marker, placed at the end of the wand handle. The distances from the origin are measured and are entered into the **Measurements** spaces. Observe the right-hand rule and make sure that you enter the data correctly. In the Z-Up example in Figure 6-3, points 1, 2, and 3 would be at +X, and point 4 would be at +Y coordinates, but adjust accordingly to your Calibration Up Axis. The vertical distances are the distance from the center of the markers (centroid) to the floor. Click on the other tabs and fill in the values accordingly. The Lenses tab should reflect the type of lenses you have in your camera (e.g. 6 mm, 17 mm, 20 mm etc.). The values for the lenses need only be approximations within a factor of two. The actual focal lengths are calculated when you process the wand data. Once you have completed filling in the details, press **Apply** and return to the Calibration window in **Cortex**.

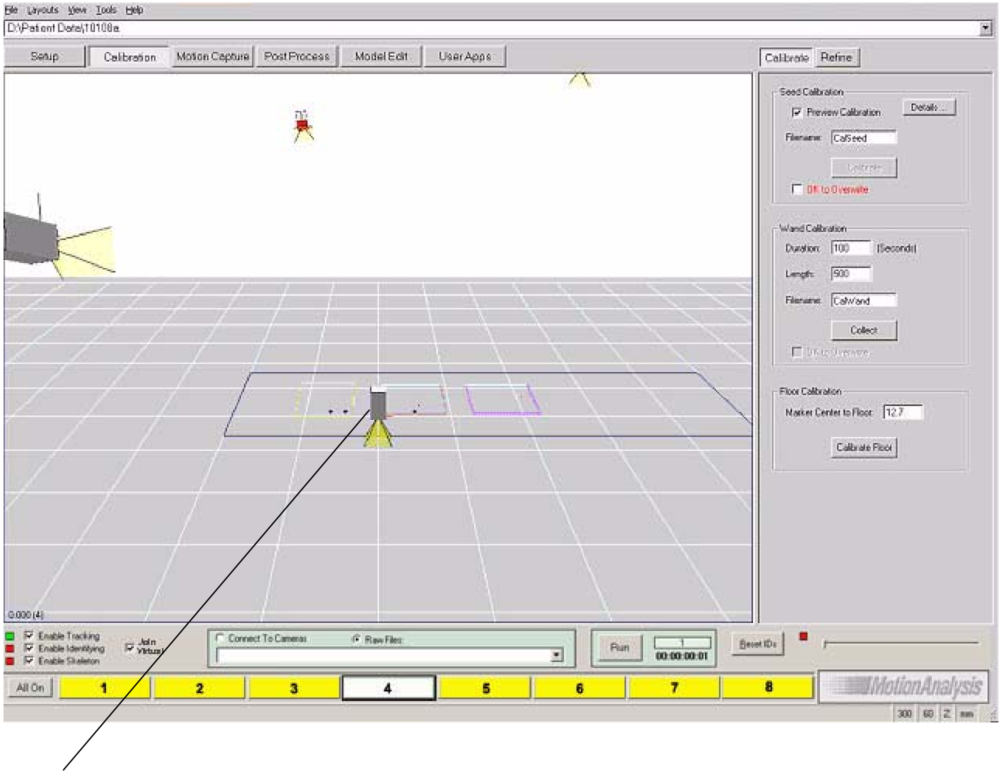
Note: Not all of the cameras need to see the L-Frame. Configurations with only 1/2 of the cameras seeing the L-Frame work very well provided there is sufficient overlap in the wand data.

Positioning/Aiming Cameras

In the Calibrate panel (under the Calibration tab), check **Camera Aiming** and then press **Run**. The cameras that see four individually defined markers will instantly adjust to their approximate positions in **Cortex** (as in Figure 6-7). If a camera does not see all four markers or sees more than four markers, it will be displayed at the origin, facing down as in Figure 6-7. This camera will not have a seed calibration, which is acceptable. Refer to “Extending the Seed Calibration” on page 6-20. If the camera is not seeing all of the points, first try one or more of the following steps:

1. Adjust the threshold to see four centroids.
2. Insert Masks to eliminate stray data points.
3. Move the camera position so that it sees four defined markers. In Figure 6-7, a poorly positioned camera will be shown as a camera situated at the origin.
4. If one camera is seen in the exact opposite position in the room, the orientation (up/down) must be changed in the Lenses tab in the Calibration Settings menu. This usually occurs when cameras are tilted more than 90° or mounted upside-down.

Figure 6-7. Poorly Positioned Camera 4 Results in a Non-Seeded Camera (Camera #4)


File
Layouts
View
Tools
Help
Setup
Calibration
Motion Capture
Post Process
Model Edit
User Apps
Calibrate
Refine
Seed Calibration
Details...
Calibrate
Wand Calibration
Collect
Floor Calibration
Calibrate Floor
Connect To Cameras
Raw Files
Run
Reset IDs
All On
1
2
3
4
5
6
7
8
MotionAnalysis
300
60
Z
mm

D:\Patient Data\10108a

☑ Preview Calibration

Filename: CalSeed

☐ OK to Overwrite

Duration: 100 (Seconds)

Length: 500

Filename: CalWand

☐ OK to Overwrite

Marker Center to Floor: 12.7

0.000 (4)

☑ Enable Tracking

☑ Enable Identifying

☑ Enable Skeleton

☑ Join Virtual

○ Connect To Cameras ● Raw Files

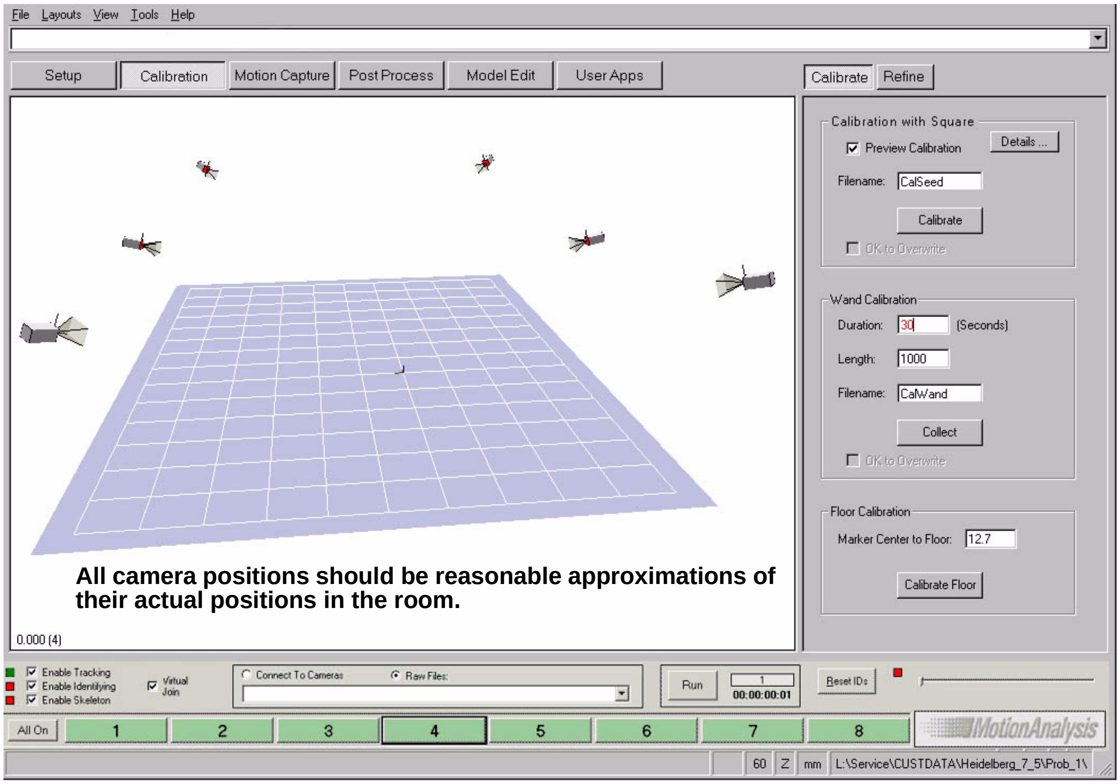
1

00:00:00:01

Example: The camera does not see the calibration L-frame. Click on the camera to identify it.

Once you have all of your cameras positioned and oriented correctly, press the **Collect and Calibrate** button (see Figure 6-8). This creates the **CalSeed.vcX** (vc1, vc2… vcN) files and consists of one frame of data stored in your current data folder. Your camera buttons at the bottom should now be yellow in color, indicating that all cameras are seeded (see Figure 6-9). Fully calibrated cameras show up as Green, but this does not happen until after wand calibration is completed.

Figure 6-8. Properly Seeded Cameras


File
Layouts
View
Tools
Help
Setup
Calibration
Motion Capture
Post Process
Model Edit
User Apps
Calibrate
Refine
Calibration with Square
Details ...
Calibrate
Wand Calibration
Collect
Floor Calibration
Calibrate Floor
Run
Reset IDs
All On
1
2
3
4
5
6
7
8
MotionAnalysis

All camera positions should be reasonable approximations of their actual positions in the room.

0.000 (4)

☑ Preview Calibration

Filename: CalSeed

☐ OK to Overwrite

Duration: 30 (Seconds)

Length: 1000

Filename: CalWand

☐ OK to Overwrite

Marker Center to Floor: 12.7

☑ Enable Tracking

☑ Enable Identifying

☑ Enable Skeleton

☑ Virtual Join

○ Connect To Cameras ● Raw Files:

1

00:00:00:01

60 | Z | mm | L:\Service\CUSTDATA\Heidelberg_7_5\Prob_1\

This completes the square part of the Square and Wand Calibration.

Calibration with Wand

Duration

This function allows the user to set the desired time limit (in seconds) for the wand capture.

Length

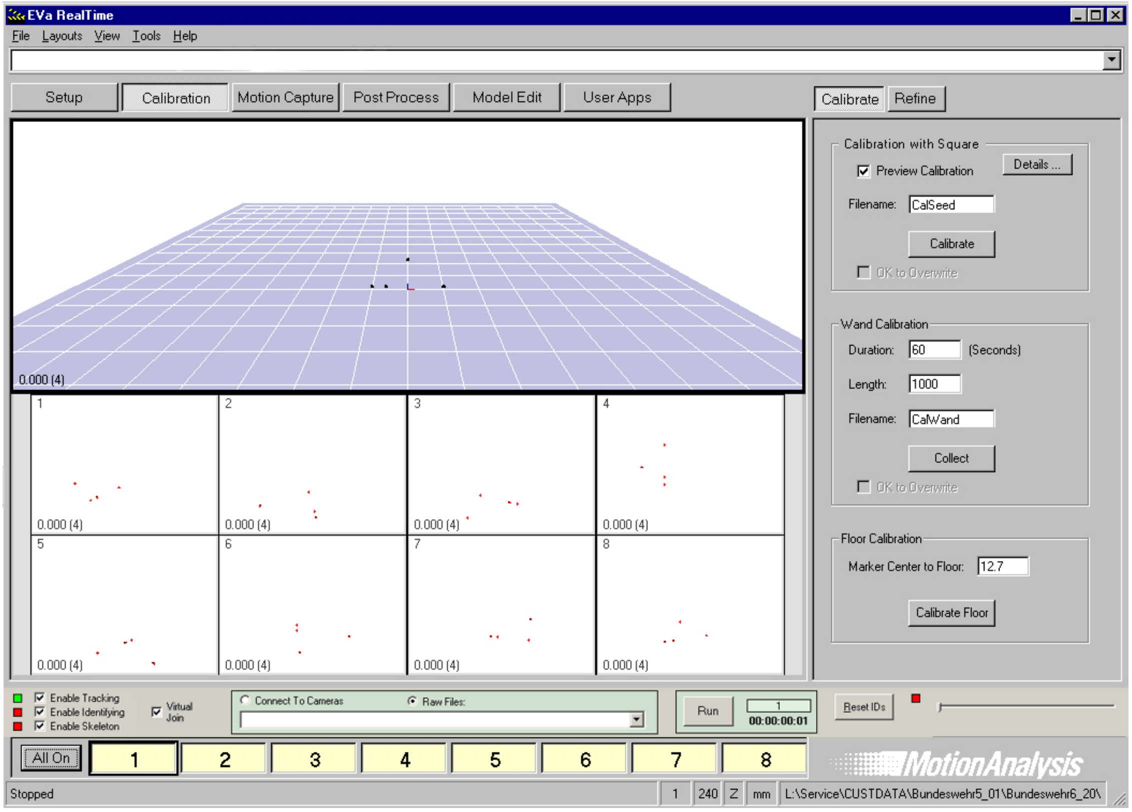
This function allows the user to set the length of the wand head (in millimeters), measured from end marker to end marker.

Calibration with Wand Procedure

1. In the Wand Calibration box on the right hand side, set the wand length to your wand size. Make sure that you are using only a three-point wand.
2. Set the duration of the trial. The duration should be sufficiently long enough to wave the wand through most of the volume that you want calibrated. Smaller volumes take less time to complete.
3. Click the **Collect and Calibrate** button and start waving the wand side to side and up and down through the volume. You want to spend about 1/3 of the data collection time with the wand parallel to each of the three X, Y, & Z axes.

Note: It is recommended that you view the wand movement through the volume at least for the first few times. To do this you must select **Layouts > Top/Bottom**. One window should reflect the 3D view and the area where it is possible to see the wand waving through the volume. The other is the 2D view where the individual camera coverage of the wand in the volume is seen. To show all cameras, press the **All On** button. In the 2D view, the display is automatically smeared in showing the wand data. This shows the volume coverage for each camera. A good wand calibration will fill most of the 2D view for each camera.

Figure 6-9. Seeded Cameras; 3-D and 2-D View (all cameras on)


EVa RealTime
File Layouts View Tools Help
Setup
Calibration
Motion Capture
Post Process
Model Edit
User Apps
Calibrate
Refine
Details ...
Calibrate
Collect
Calibrate Floor
0.000 (4)
1
2
3
4
5
6
7
8
Run
00:00:00:01
Reset IDs
All On
MotionAnalysis

Calibration with Square

☑ Preview Calibration

Filename: CalSeed

☐ OK to Overwrite

Wand Calibration

Duration: 60 (Seconds)

Length: 1000

Filename: CalWand

☐ OK to Overwrite

Floor Calibration

Marker Center to Floor: 12.7

☑ Enable Tracking

☑ Enable Identifying

☑ Enable Skeleton

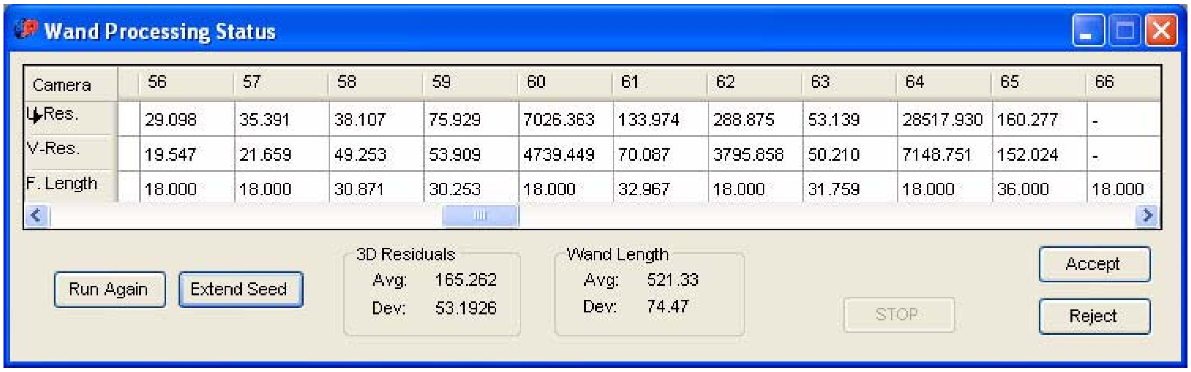
☑ Virtual Join

○ Connect To Cameras ● Raw Files:

Stopped | 1 | 240 | Z | mm | L:\Service\CUSTDATA\Bundeswehr5_01\Bundeswehr6_20\

4. Once the wand calibration duration has been completed, the program starts to determine the volume calibration, and a screen comes up with a series of numbers that decrease as the calibration nears the actual wand length and focal lengths of the camera lenses (see Figure 6-10).
5. At the bottom of the user interface, a progress bar ticks toward 100%. Once completed, the camera lenses should be very close to what was installed on the camera body (e.g. 6.023 mm for 6 mm lenses). If this is the case, and the wand length is very close (e.g. within 0.10 mm difference for a 500.00 mm wand) to the original wand length, then the calibration is complete. If not, you can continue to click on the Run Again button until either the values stop changing significantly, or the values start getting larger.
6. Press **Save Setup**.

Figure 6-10. Wand Processing Status



Camera	56	57	58	59	60	61	62	63	64	65	66
U-Res.	29.098	35.391	38.107	75.929	7026.363	133.974	288.875	53.139	28517.930	160.277	-
V-Res.	19.547	21.659	49.253	53.909	4739.449	70.087	3795.858	50.210	7148.751	152.024	-
F. Length	18.000	18.000	30.871	30.253	18.000	32.967	18.000	31.759	18.000	36.000	18.000

3D Residuals
Avg: 165.262
Dev: 53.1926

Wand Length
Avg: 521.33
Dev: 74.47

Extend Seed Button

This button will seed the cameras that were not seeded during the Seed Calibration, based on the wand data. After extending the seed (clicking **Extend Seed**), all the camera buttons should be yellow. Click **Run Again** to complete the wand calibration for all cameras.

Note: Not all of the cameras need to see the L-Frame. Configurations with only 1/2 of the cameras seeing the L-Frame work very well provided there is sufficient overlap in the wand data.

Run Again Button

This button continues the refinement of the wand calibration. If the numbers in Figure 6-10 continue to change, click **Run Again** for a more precise calibration.

Accept Button

Click this button if the calibration numbers look sufficient.

Reject Button

Click this button if the calibration numbers are unacceptable. Fix the problem, then select **Run Again.** A typical fix, without having to recollect the data, is that you can create a mask in one of the Raw Video **CalWand.vcX** files.

Stop Button

If you need to stop in the middle of a calibration, or the numbers are not improving during a lengthy calibration click the **Stop** button.

Note: The Stop button is not a cancel button. You can click **Stop** and then **Accept** if you wish to keep the calibration numbers.

Floor Calibration

Floor Calibration Procedure (Optional)

It is necessary to perform a floor calibration if your floor is uneven or if the L-Frame is placed in a location that does not adequately represent a flat floor in the capture volume.

1. After the Seed and the Wand calibration is processed, place several markers on to the floor.
2. Press the **Connect** button and then the **Run** button. You should see the unidentified markers on the floor.
3. Enter the distance from the floor (your y=0 plane for Y-up) to the center of the markers (maybe 20 mm) and press the **Collect and Calibrate** button in Floor Calibration.
4. It will tell you how much the calibration origin was moved and rotated with a six number display which stands for the XYZ and yaw, pitch and roll adjustments.

From VC Files

If you are doing this from VC files, you will need to do the following:

1. Select the **CalFloor.vc1** file from **File > Load Capture** (with the cameras disconnected).
2. Then press the **Run** button so that you see the unnamed markers on the floor in the 3D view.
3. Then press the **Collect and Calibrate** button in Floor Calibration.

CalFloor.vcX (optional)

You would not normally need this, but it is there to “level the floor” if needed. It is typical to take a single walk cycle and copy and paste it into 100 cycles. If the Calseed device is slightly tilted up or down, this can cause the stick figure to be walking above or below the floor at the ends of the cycles. To correct for this, you can spread 4 or more markers on the floor and press the Calibrate button in the Floor Calibration box.

Note: Make sure no other markers (ghost or otherwise) are visible in the 3D View, as it will tilt your new virtual floor to average them in as well.

Marker Center to Floor

This setting is used to adjust the floor level of the capture volume, based on the size of markers (in mm) used to determine the plane of the volume floor. For example, if 12 mm markers are spread across the volume floor, a Marker Center to Floor value of 6mm (radius of marker) plus any base pad thickness would be entered into this box.

Refine Camera Positions Button

After you calibrate the system, you can use the Refine panel to either improve your calibration or to fix the calibration if a camera gets bumped or the cameras have moved slowly over time. You can choose to refine all cameras or refine only the selected cameras. If you refine the selected cameras, the calibrations will remain unchanged for the non-selected cameras.

When performed well, the Refine Cameras function can greatly improve the accuracy of the system, and will fix a bumped camera, all within 60 seconds. It is one of the most powerful tools in **Cortex**. To use it, check the **Refine Camera Positions** check box press the **Run** button when connected to your cameras. Have a subject move about in the capture volume. Like with wand calibration, you must cover the entire capture volume and field of view for each camera with any marker data. If you get good coverage, then refined calibration will be very good. If you get only partial coverage, then you the results may be worse than not doing the refine.

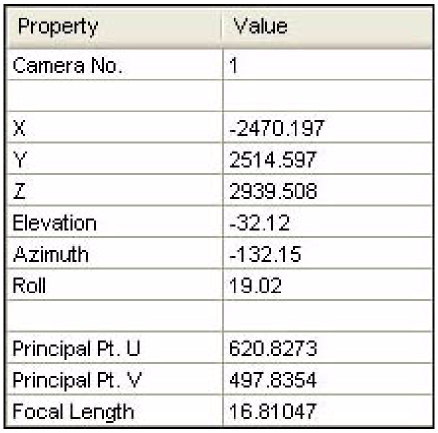
Modify Only the Selected Cameras

When checked, the seed, wand, and refine calibrations will only affect the cameras that are selected on the dashboard.

Camera Position and Properties

The panel on the bottom of the Calibrate panel displays the details of the selected camera in the 2D view. You can move and rotate the cameras in the 3D View by changing the X, Y, Z coordinates, and the Elevation, Azimuth, and Roll angles. This can be helpful to see if moving the cameras will help with seeing the volume better. Once you have finished positioned the cameras, select **File > Save Setup As...** to save this camera configuration for viewing at a later time.

Figure 6-11. Selected Camera Information



Property	Value
Camera No.	1
X	-2470.197
Y	2514.597
Z	2939.508
Elevation	-32.12
Azimuth	-132.15
Roll	19.02
Principal Pt. U	620.8273
Principal Pt. V	497.8354
Focal Length	16.81047

Refine Procedure

1. Connect to cameras (or select a Raw Video file).
2. Select and activate the **Refine Camera Positions** and **Modify only the SELECTED cameras** check boxes.
3. Press the **Run** button on the Real Time Dashboard.
4. Press **All On** on the Real Time Dashboard so that all camera views are displayed on the 2D Display.
5. Right-click on the 2D Display and select **Smear Display**. This will show you how much of each camera's field of view is being filled by the wand over time.
6. Start with the subject in one corner and as soon as the subject starts to move, check the check box for Refine Camera Positions.

7. Have the subject walk around the capture volume filling the entire volume. The subject is acting like a wand calibration. Have the subject walk with both arms slightly out so that all markers are easily identified. Then, have the subject walk the perimeter of the room, spiraling into the middle.
8. As soon as the subject has filled the room and reached the middle, press **Pause**.
9. A table of correction values will appear for all cameras included in the Refine panel. The first three columns are the position changes of the cameras since the original calibration and the second three columns are the rotational changes. Changes of more than 1 mm are often significant and can result in a better calibration.
10. Click **OK** and save as a new setup.
11. Press **Run** to start **Cortex** again. You should now see lower residuals and fewer ghost markers.

There are a few things to be concerned about. Since this behaves just like a wand calibration, and if the subject does not fill the volume during the Refine trial, the calibration can be poor and even worse than before the Refine. If the subject spends a lot of time in one area and not much in another, it can also be poor. If the markers are not identified, then there is no information for the Refine, so ensure that the subject is identified. Save the Refine as a new setup (e.g. **Refined.cal**) so that if the new calibration is not as good as before, you can go back to the previous setup file. The other thing to remember is that the Refine does not guarantee that the scale is exactly maintained. It just optimizes the camera locations to track the markers better. In effect, the scale of the room may change slightly. The reality is that Refining once does not change the scale. It is not recommend to do many Refine Cameras in a row to improve the results, since this may change the scale.

Note: You do not need an identified stick figure to refine, you only need to see 3D unnamed (or named) markers to refine the calibration.

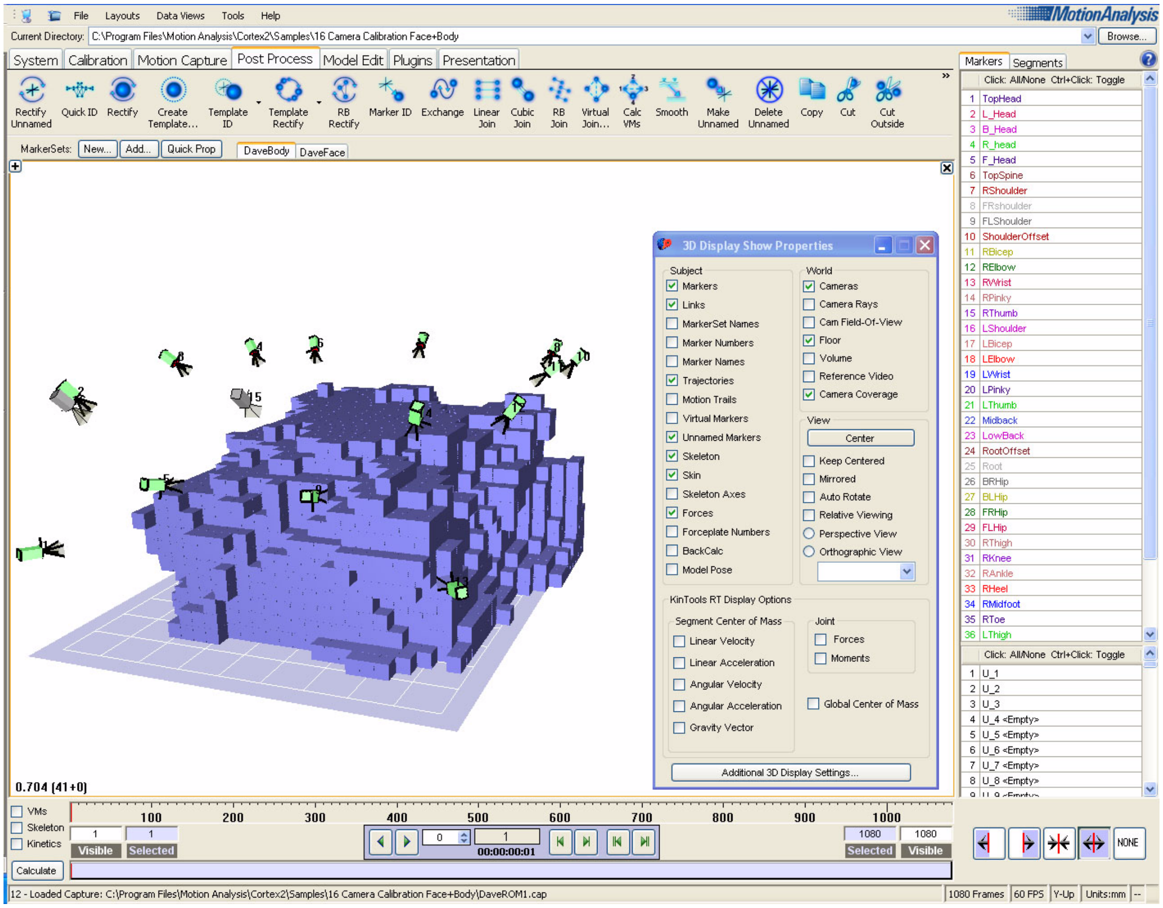
You can use any 3D data points to Refine the calibration. There does not need to be a template or a stick figure. Any data that fills the volume will be sufficient. You can have a markered subject walk in and around the capture volume, with emphasis on the edges. The ray intersection of both the named and un-named markers can be used to refine the calibration. However, if a camera was severely bumped, calibration will be far enough away from ray intersections that the Refine Calibration will not help. In that case, you must redo the L-frame and wand calibration steps.

Show Camera Volume

Show Camera Volume is useful for telling you about how well your cameras are aimed and how much camera overlap you have. To see the camera volume:

1. Right-click in the 3D View and then select the **Camera Coverage** check box in the pop-up. You will need to select the camera number(s) button at the bottom of the Motion Capture panel. Also, you can change the minimum number of cameras that see that part of the volume in the **Tools > Settings > 3D Display > Camera Coverage > Minimum Number of Cameras** setting.
2. Right-click in the 3D view and select **Show Volume**.

Figure 6-12. Show Camera Coverage, Volume



File
Layouts
Data Views
Tools
Help
MotionAnalysis
Current Directory: C:\Program Files\Motion Analysis\Cortex2\Samples\16 Camera Calibration Face+Body
Browse...
System
Calibration
Motion Capture
Post Process
Model Edit
Plugins
Presentation
Rectify Unnamed
Quick ID
Rectify
Create Template...
Template ID
Template Rectify
RB Rectify
Marker ID
Exchange
Linear Join
Cubic Join
RB Join
Virtual Join...
Calc VMs
Smooth
Make Unnamed
Delete Unnamed
Copy
Cut
Cut Outside
MarkerSets:
New...
Add...
Quick Prop
DaveBody
DaveFace
0.704 (41+0)
Markers
Segments
Click: All/None Ctrl+Click: Toggle
1 TopHead
2 L_Head
3 B_Head
4 R_head
5 F_Head
6 TopSpine
7 RShoulder
8 FRshoulder
9 FLShoulder
10 ShoulderOffset
11 RBicep
12 RElbow
13 RWrist
14 RPinky
15 RThumb
16 LShoulder
17 LBicep
18 LElbow
19 LWrist
20 LPinky
21 LThumb
22 Midback
23 LowBack
24 RootOffset
25 Root
26 BRHip
27 BLHip
28 FRHip
29 FLHip
30 RThigh
31 RKnee
32 RAnkle
33 RHeel
34 RMidfoot
35 RToe
36 LThigh
Click: All/None Ctrl+Click: Toggle
1 U_1
2 U_2
3 U_3
4 U_4 <Empty>
5 U_5 <Empty>
6 U_6 <Empty>
7 U_7 <Empty>
8 U_8 <Empty>
VMs
Skeleton
Kinetics
Calculate
100
200
300
400
500
600
700
800
900
1000
1
1
Visible
Selected
0
1
00:00:00:01
1080
1080
Selected
Visible
NONE

3D Display Show Properties

Subject
☑ Markers
☑ Links
☐ MarkerSet Names
☐ Marker Numbers
☐ Marker Names
☑ Trajectories
☐ Motion Trails
☐ Virtual Markers
☑ Unnamed Markers
☑ Skeleton
☑ Skin
☐ Skeleton Axes
☑ Forces
☐ Forceplate Numbers
☐ BackCalc
☐ Model Pose

World
☑ Cameras
☐ Camera Rays
☐ Cam Field-Of-View
☑ Floor
☐ Volume
☐ Reference Video
☑ Camera Coverage

View
Center
☐ Keep Centered
☐ Mirrored
☐ Auto Rotate
☐ Relative Viewing
○ Perspective View
○ Orthographic View

KinTools RT Display Options
Segment Center of Mass
☐ Linear Velocity
☐ Linear Acceleration
☐ Angular Velocity
☐ Angular Acceleration
☐ Gravity Vector

Joint
☐ Forces
☐ Moments

☐ Global Center of Mass

Additional 3D Display Settings...

12 - Loaded Capture: C:\Program Files\Motion Analysis\Cortex2\Samples\16 Camera Calibration Face+Body\DaveROM1.cap | 1080 Frames | 60 FPS | Y-Up | Units:mm

Calibration Files

The following are the types of calibration files generated in your selected capture folder:

Calseed.vcX

Calseed.vcX files (one for each camera) get written when you press the **Calibrate** button in the Calibration with L-Frame box and when you are connected to the cameras. If you are not connected to the cameras, you can use the Disconnect-Use Raw Files item and select the **Calseed.vc1 or Calseed.cap** file to re-process the Calseed files. This is a kind of simulated realtime mode that allows you go back and process the **Calseed** files and evaluate your data files. When you press the **Calibrate** button in the Calibrate with Square box, it completely removes all of your calibration information and replaces it with the seed or approximate calibration for each camera.

Note: vcX means the set of files that end in vc1, vc2.... vcN if you have N cameras.

Calwand.vcX

Calwand.vcX and **Calwand.cap** files get written when you press the **Calibrate** button in the Calibration with Wand box and when you are connected to the cameras. If you are not connected to the cameras, you can process the data in the simulated real time mode as above. The software uses the current system calibration (which is normally the results of the seed calibration, but can be otherwise) and refines the calibration. The calibration includes the exact location and orientation of each camera with respect to the origin, the lens distortion parameters for each camera, and other details about the cameras. At the successful completion of the wand calibration, the software asks if you want to save the system calibration. A **Yes** answer means that a file called **SystemSetup.cal** gets written to the system directory.

Other uses for the **SystemSetup.cal** file are when you launch **Cortex**, the software automatically reads the **SystemSetup.cal** file and when you exit the **Cortex** program, it automatically writes the **SystemSetup.cal** file into the **UserFiles\System** folder. The intent is so that you can launch the **Cortex** software and it will remember its last good calibration without having to load any files. If you load a PRJ file or load a CAL file, it will overwrite the calibration information in memory with the contents of the PRJ or CAL file. Both contain calibration information, but the legacy PRJ file also has the marker set information and template information.

TrialN.cal

Every time you collect a trial in the **Motion Capture > Output** panel, the system writes out the current calibration to a file that has the same name as your trial name, but with a **.cal** extension. This is normally not needed, but will allow you to load up the calibration at the time of the capture with the **File > Load Calibration...** menu item. If you changed the calibration for some reason and you know you were calibrated when the trial was collected, you can load up that as the current calibration in the software at a later time.

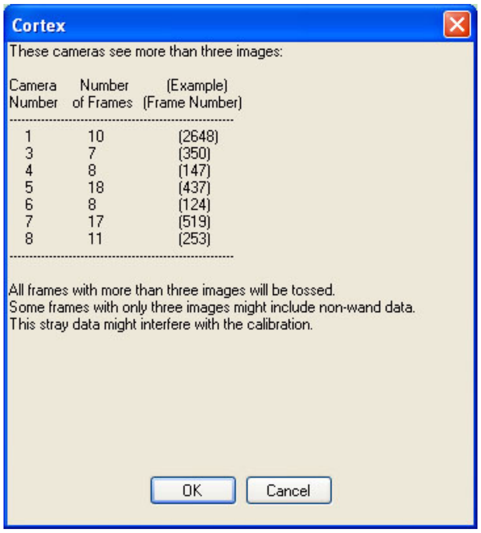
Calibration from Previously Collected Files

This section describes how to simulate a calibration using previously recorded data. A simulated collection of **Cortex** square or wand data is done the same way that you can simulate tracking Raw VC data. Just follow these steps:

1. Disconnect from your cameras.
2. Select **Raw Files** on the Real Time Dashboard.
3. Load the **CalSeed.vc1 or CalSeed.cap** file. At this point, you can mask out any extraneous data points if necessary.
4. Press the **Run** button on the Real Time Dashboard.
5. In the Calibrate panel, press **Calibrate** in the Calibration with Square box.
6. The cameras buttons on the Real Time Dashboard should turn Yellow which indicates calibration is square, but not wand calibrated. White means not square. Green means fully calibrated.
7. Select **Raw Files** on the Real Time Dashboard.
8. Load the **CalWand.vc1 or CalWand.cap** file. At this point, you can mask out any extra data points that might be causing problems. This feature allows you to utilize wand data sets if there are extra markers in the field of view of one or more cameras.
9. In the Calibrate panel, press **Calibrate** in the Calibration with Wand box. You will see the wand results, see the cameras move to their final place, and see the measured focal distances.

Note: You can use these steps to mask out unwanted data after you do a wand calibration. Most of the time, there is no need to collect a new wand data set. If you have one or more wand files that contain many (>100) frames with more than three images, you can select **File > Load Capture (Live)... (**or the **CalWand.cal** file), mask out the offending region(s) and calibrate from the previously captured and newly markered files.

Figure 6-13. Wand Results - Frames with More than Three Images



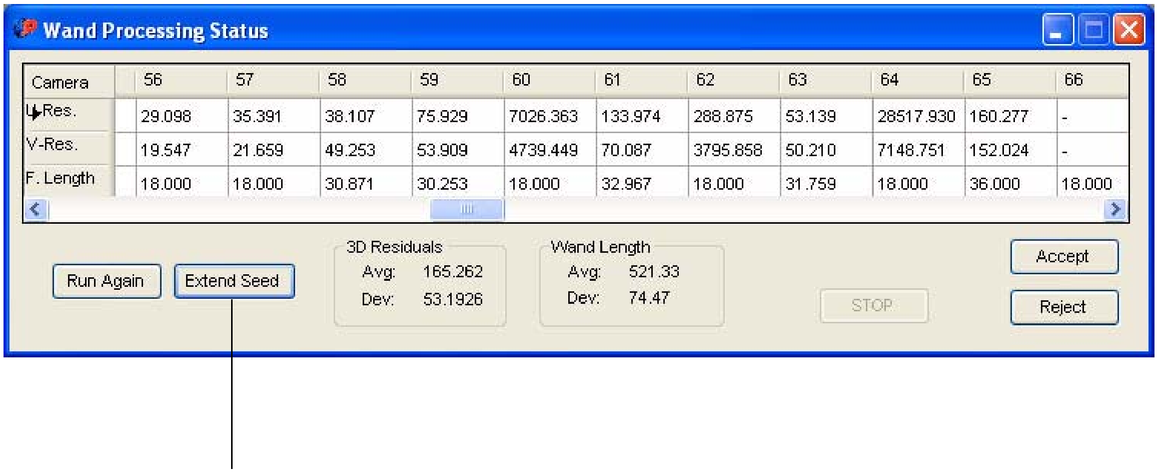
```
These cameras see more than three images:

Camera    Number       (Example)
Number   of Frames  (Frame Number)
------------------------------------------------
   1        10           (2648)
   3        7            (350)
   4        8            (147)
   5        18           (437)
   6        8            (124)
   7        17           (519)
   8        11           (253)
------------------------------------------------

All frames with more than three images will be tossed.
Some frames with only three images might include non-wand data.
This stray data might interfere with the calibration.
```

Extending the Seed Calibration

If one or more cameras are not seeing the four-point calibration L-frame device for any reason, they have not been properly calibrated and it shows up as a white camera button. The camera is shown on the floor at the origin point down, as shown in Figure 6-7 on page 6-9. This will result when you have a large capture volume and only some cameras see the calibration L-frame or a camera threshold may be set incorrectly. This is not a problem. You can use the wand data to get the camera calibration seeded, then process the wand data again so the camera (or cameras) get both square and wand processing. The steps for this are as follows:

1. Calibrate using the calibration L-frame as described in “Calibration Frame Tab” on page 6-5. Cameras that are Yellow are seeded. Those that remain White are unseeded and show up on the floor, at the origin pointing down.
2. Process the wand data. The cameras that saw the calibration L-frame will show as Green camera buttons; the unseeded cameras remain White.
3. Extend the calibration seed by clicking **Extend Seed.** This will then seed those cameras previously unseeded.
4. Click on **Run Again**. This runs the wand data again for all cameras. After this, all cameras should be Green (calibrated).

Figure 6-14. Extend Seed Calibration Button



Camera	56	57	58	59	60	61	62	63	64	65	66
U-Res.	29.098	35.391	38.107	75.929	7026.363	133.974	288.875	53.139	28517.930	160.277	-
V-Res.	19.547	21.659	49.253	53.909	4739.449	70.087	3795.858	50.210	7148.751	152.024	-
F. Length	18.000	18.000	30.871	30.253	18.000	32.967	18.000	31.759	18.000	36.000	18.000

3D Residuals
Avg: 165.262
Dev: 53.1926

Wand Length
Avg: 521.33
Dev: 74.47

Extend Seed Button

Note:

1. After you have clicked on **Extend Seed**, check that the residual value for each camera is at a reasonable level. If all cameras do not eventually seed, you will need to check your Wand coverage.
2. Extending the seed can be done to half or more of your cameras with excellent results as long as you have overlapping wand data for all cameras.

Post Processing Square and Wand Data

It is possible to process the square and wand data after the data has been collected. This is helpful if you did not have the time to process it during the capture or if you lost the capture file that contains the calibration information. The steps are as follows:

Note: You must have the **CalSeed.vcX or CalSeed.cap** and the **CalWand.vcX or CalWand.cap**files from the data capture session.

1. Select **Raw Files** in the Real Time Dashboard and then select **CalSeed.vc1**. Select your CalSeed data set in the data capture folder.

Note: You can create a mask to eliminate unwanted markers or reflections. Reselect the **CalSeed.vc1** file again and press the **Calibrate** button in the Calibration with Square section.

2. In the Calibration with Square section of the Calibration panel, click **Calibrate**.
3. Select **Raw Files** in the Real Time Dashboard and then select **CalWand.vc1 or CalWand.cap**. Select your CalWand data set in the data capture folder.

Note: You can create a mask to eliminate unwanted markers or reflections. Reselect the **CalSeed.vc1 or CalSeed.cap** file again and press the **Calibrate** button in the Calibration with Square section.

4. In the Calibration with Wand section of the Calibration panel, click **Calibrate.**
5. Complete the wand calibration as described in “Calibration with Wand” on page 6-11.

Troubleshooting the Wand Calibration

If you are having trouble getting the system to calibrate due to the wand images being blocked by some cameras, things to try in increasing difficulty for the user are as follows:

Simplest method—Using the existing Calibration, Check Protect Lens Correction in the Calibration Panel and

1. Select the problem cameras, use Refine Selected cameras by waving the wand to cover only those cameras. The un-selected cameras are not affected.
   Or
2. Use Refine ALL cameras by waving the wand to cover all cameras. This has often worked better than refine selected cameras.
   Or
3. Do a new wand calibration (with Protect Lens Correction CHECKED). This will keep the lens corrections and other internal camera parameters alone and establish only the camera locations. This takes less data and should be accomplished with many fewer wand frames.

The most thorough method and needing the most good wand data:

Do the full Calseed/Calwand Calibration with Protect Lens Protection UN-CHECKED. This must be done if you change any lens focus or zoom settings.

Disabling cameras from the calibration process for further troubleshooting:

If you cannot figure out which camera(s) are causing the wand calibration to fail, you can disable cameras and process the data until you find the problem cameras. Disconnect from the cameras, Select the CalSeed.cap file, press the Calibrate button in the "Calibration with L-Frame" section. INSPECT the locations of the cameras. If any are flipped to the other side of the room, toggle the Lenses/Orientation from Normal to Alternate and repeat. If this does not help, try disabling half of the cameras at a time, process the CalSeed and the CalWand files. This procedure of disabling half of the remaining cameras should pinpoint which cameras are causing the problem(s).

Chapter 7 Motion Capture Tab

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Overview

Motion Capture is the mode where you will spend most of your time during a recording session. In this mode you can:

- Create and improve a template
- Set the tracking parameters
- Save data in a variety of file formats

These functions are described in this chapter.

There are a few preliminary steps that must be taken before starting a successful motion capture session. Tracking parameters tuned to your system must be set. Names must be assigned to the markers that will be used. These names constitute a marker set and building this set is actually done using the Model Edit tools discussed in Chapter 9, Model Edit Tab. A template specific to the markers in use must be created. A template describes the minimum and maximum distances that separate linked markers, such as the distance between the right elbow and the right wrist. Templates are created using Motion Capture tools and Post Process tools described in Chapter 8, Post Processing Tab. Once these steps are completed, you are ready to begin a motion capture session.

Building a Template from the Range of Motion Trial

A template is what is used to automatically identify markers in real time and post processing's Template Rectify button. In saving the template, the software stores the minimum and maximum distances that can exist between markers that have linkages. It is necessary to allow the software to identify each marker in each frame. Template information is saved in the capture (**.cap**) file.

Before a template can be created, a marker set that will apply to the subject being captured must exist. If such a marker set does not exist, it must be built using the Model Edit tools described Chapter 9, Model Edit Tab. Once an appropriate marker set exists, follow these steps to create a template.

1. Choose **Motion Capture** from the Mode Buttons.
2. Choose **Output** from the panel buttons.
3. Check the **Tracked ASCII (TRC) or Tracked Binary (TRB)** check box on the Output panel.
4. Type a file name in the name box and press **Enter**.
5. Set the Duration (seconds) between **10** and **20**.
6. Start collecting the range of motion data of the subject by having the person stand in the middle of the capture volume with arms extended, palms parallel to the floor with thumbs facing forward, and all markers in full view.
7. Click **Record** on the Output panel.
8. The subject must stay in an initial frozen position for two or three seconds.
9. After standing frozen in this initial position for up to five seconds, the person must move through a complete range of motion by moving and twisting, ensuring that each linkage exhibits the full extent of stretch that will be experienced during subsequent motion capture sessions. Exaggerated motion must be avoided and all markers should remain in full view. This step should not require more than fifteen seconds.
10. After ten seconds passes from the moment **Record** was clicked, the system will automatically stop collecting and tracking marker data.

At this point, a Tracked ASCII (TRC) or Tracked Binary (TRB) file has been generated in the current directory and is ready for editing. Next, the markers must be hand identified according to the marker list built for the subject's marker set (assuming that the marker list was already defined prior to the motion capture).

11. Choose **Post Process** from the Mode Buttons.
12. Click **Quick ID** and identify the unnamed markers according to the conventions described in Appendix C, Marker Sets.
13. Click **Rectify**. This applies the naming convention across all the frames of data.
14. Manually cleanup and identify all tracks in this range of the motion file. The template should be defined as at least 75% of the visible frames selected.
15. Select **Template**.

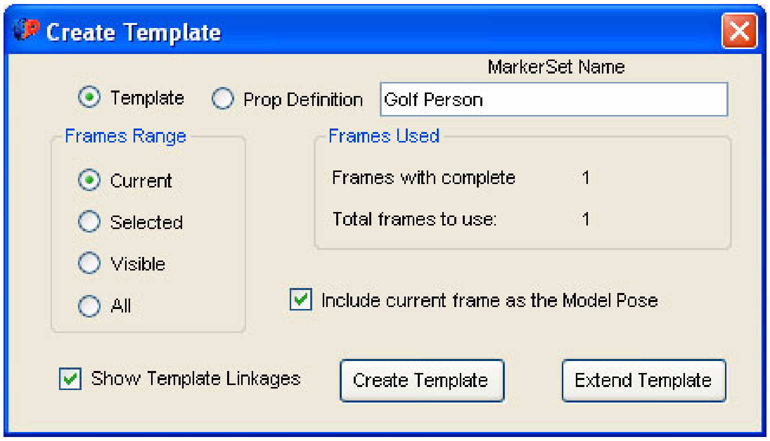
16. Click **Create Template** (for more information on the Create Template Interface, refer to "Template Create..." on page 8-12).

17. Select the appropriate Frames Range:

- **Current**—the current displayed frame
- **Selected**—frames highlighted in blue, low to high in dashboard
- **Visible**—what is displayed across the screen, as a function of the time zoom
- **All Frames**—all frames

18. Click **Create Template**.

Figure 7-1. Create Template Interface



● Template ○ Prop Definition

MarkerSet Name: Golf Person

● Current
○ Selected
○ Visible
○ All

Frames with complete 1
Total frames to use: 1

☑ Include current frame as the Model Pose

☑ Show Template Linkages

Prop Definition

Selecting Prop Definition creates a **<projectname>.prop** file that is a rigid body measurement of the object. This .prop file can then be selected as one of the "Additional Tracking Objects" in the **Motion Capture > Objects** panel.

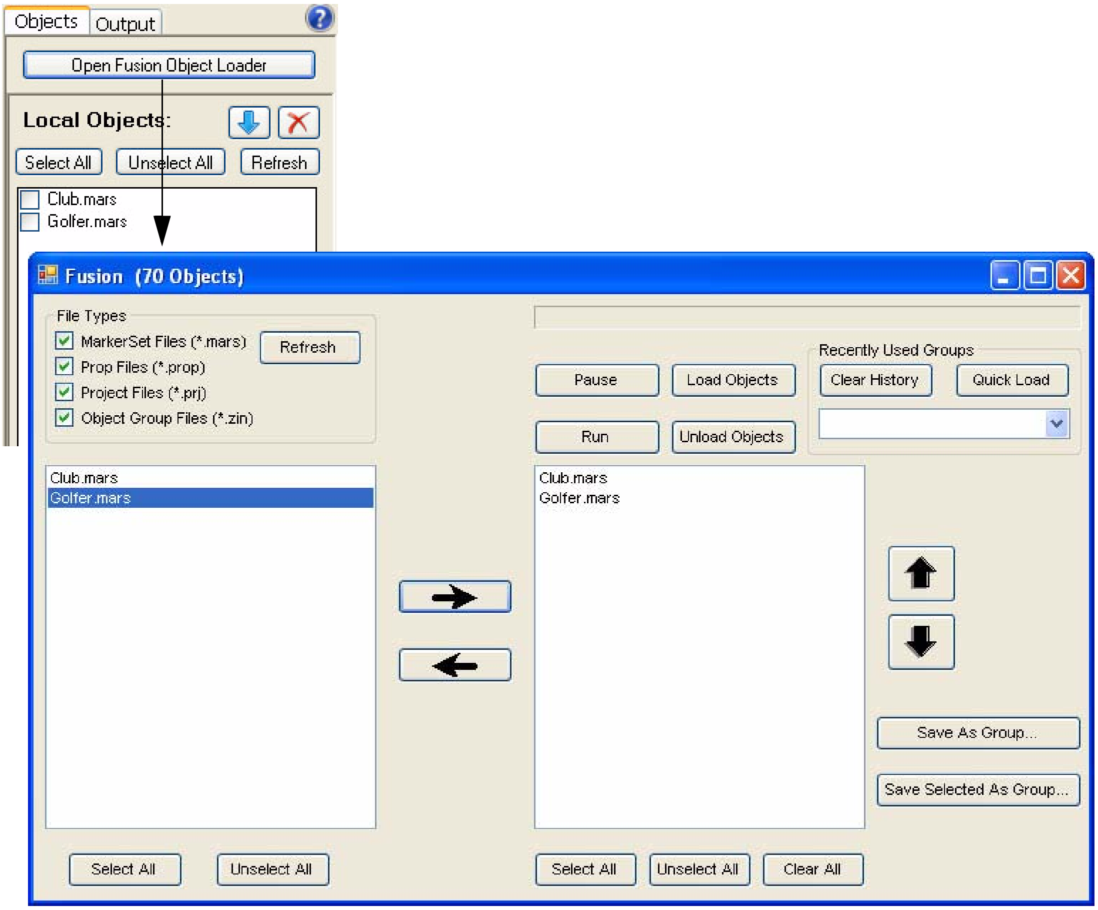
Objects Panel

The Objects panel provides the interface to work with multiple marker templates (objects) at one time. This will include multiple persons and props.

Open Fusion Object Loader

The Fusion Objects Loader provides a method of managing tracking objects in **Cortex**. It can load (and unload) objects in **Cortex** from Capture files, prop files, and Fusion Group files. The Fusion Control Panel features a button which launches the Fusion Objects Loader window, as shown in Figure 7-2.

Figure 7-2. Fusion Control Panel and Fusion Object Loader Interface


Objects
Output
Open Fusion Object Loader
Local Objects:
Select All
Unselect All
Refresh
Club.mars
Golfer.mars
Fusion (70 Objects)
File Types
MarkerSet Files (*.mars)
Prop Files (*.prop)
Project Files (*.prj)
Object Group Files (*.zin)
Refresh
Pause
Load Objects
Run
Unload Objects
Recently Used Groups
Clear History
Quick Load
Club.mars
Golfer.mars
Club.mars
Golfer.mars
Save As Group...
Save Selected As Group...
Select All
Unselect All
Select All
Unselect All
Clear All

Installation

The Fusion Object Loader plugin is part of the standard **Cortex** software installation. It uses a Dynamic Link Library (**Fusion.dll**) file which **Cortex** uses as an additional resource. This file is installed into the **C:\Program Files\Motion Analysis\Cortex2\Release2.X.X\Plugins** folder. Any **Cortex** plugin dll placed in this folder will automatically be recognized and used by **Cortex**.

When initially installed, the Fusion Object Loader control is found in the Plugins tab of the **Cortex** interface. As an option, you can move the plugin to another tab if it better fits the way you use it. For example, you may wish to move the Fusion Control panel to the Motion Capture tab, since that is where it is typically used.

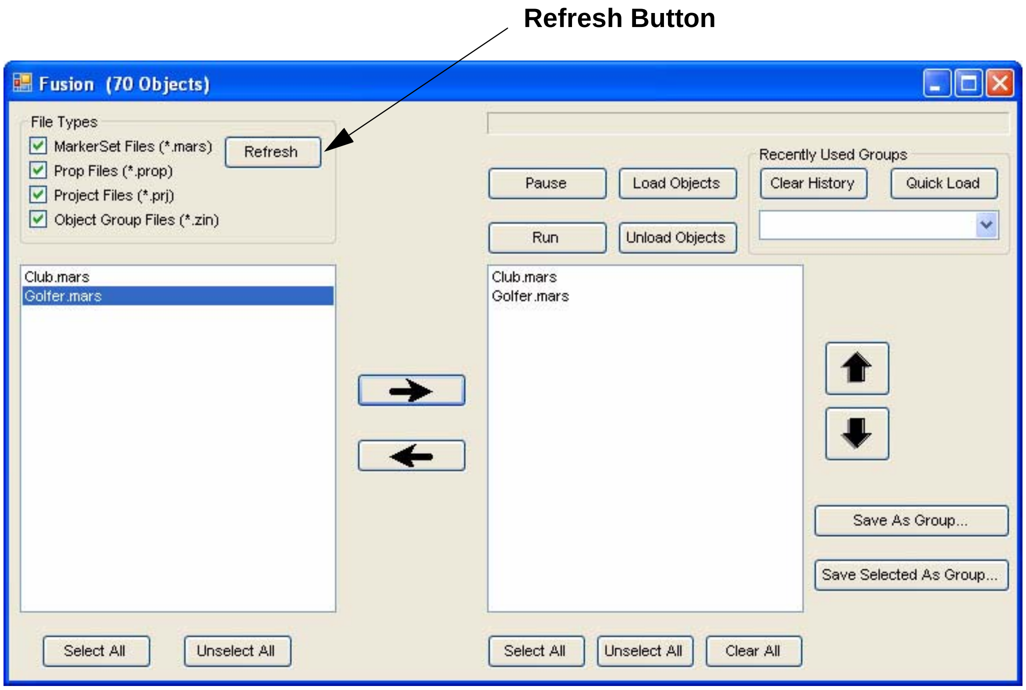
To move the Fusion control panel to a new tab, select the **Tools > Settings > Plugin** tab. From there, you can choose from the list of available tabs.

Using the Fusion Object Loader

The Title bar of the Fusion Object Loader displays the number of objects that can be loaded into your version of **Cortex** in parenthesis. On the left, there is a set of radio buttons to select the type of file from which you wish to load objects, including *.cap (**Cortex** capture files), *.prop (**Cortex** prop files), or *.zin (Fusion Group files). Depending upon your selection, that type of file (from the current capture directory) is displayed in the list below (on the left). Any or all of the files listed can be moved into the list to the right using either the right arrow button for any selected files, or select and drag and drop into the window from the left to the right. The right list is a “staging list” for objects to be loaded into **Cortex** when the list is ready. Additionally, you may use the File Manager to drag and drop these files into the right list. The files you use should be from the current capture directory.

Note: If you leave the Fusion Object Loader window open while working, and happen to change capture directories, you need to select the **Refresh** button on the Object Loader to get a correct list of files in the new directory.

Figure 7-3. Fusion Objects Loader Interface with Prop and Capture Files


Refresh Button
Fusion (70 Objects)
File Types
☑ MarkerSet Files (*.mars)
☑ Prop Files (*.prop)
☑ Project Files (*.prj)
☑ Object Group Files (*.zin)
Refresh
Club.mars
Golfer.mars
Pause
Load Objects
Run
Unload Objects
Recently Used Groups
Clear History
Quick Load
Club.mars
Golfer.mars
Save As Group...
Save Selected As Group...
Select All
Unselect All
Select All
Unselect All
Clear All

If you use .zin group files, they contain multiple objects in a group. Moving the .zin file from the left to the right expands the list to the individual objects in the .zin file. These group files are created by using the **Save As Group** and **Save Selected As Group** buttons on the right side of the Fusion Object Loader window. These buttons save all the objects (or the selected ones) from the staging list on the right into the group file so you can preserve the list and the ordering in one group that you can re-use. You may find that the order will affect the speed and accuracy of Identifying during the motion capture session. You may use the Up and Down arrows to move objects up or down in your staging list if necessary.

Refer back to Figure 7-3. You will find an example of a group of objects staged and ready to load. Note it includes both .prop and .prj type objects.

Loading Objects

Once your staging list is complete, all the objects contained in it can be loaded into the Additional Tracking Objects list at the press of a button. Since you cannot load objects while capturing data, there are Pause and Run buttons in the Fusion Object Loader to allow you to control the capturing state of the system. Next to the Pause and Run buttons are the Load Objects and Unload Objects buttons. These are used to move the objects into and out of the Additional Tracking Objects list.

From the paused state, press **Load Objects**. You will then see that the **Additional Tracking Objects** list located in the **Motion Capture > Objects** panel will be populated with the first ten of the objects in your list, and the rest (up to the maximum listed in the Title Bar) will also be loaded, in the order in which they appear in the list.

Above the buttons on the right is a status message area, which will indicate the status of your last operation. If all objects were successfully loaded, you will see a massage confirming this.

An unsuccessful object load function is generally caused by something in the list not being present in the current capture directory. If you change capture directories, or have deleted a prop or capture file for an object in a group file, that can be the cause.

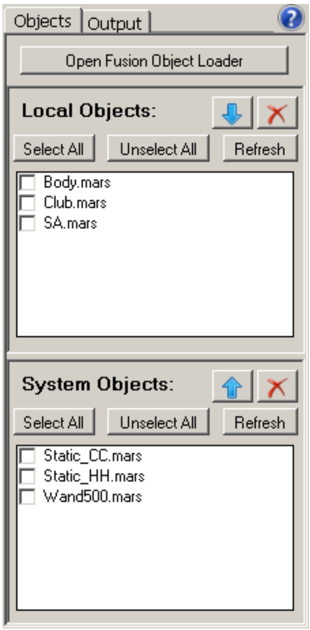
If you are working from .zin files, they are remembered in the “Recently Used Groups” list, and can be loaded using the **Quick Load** button. This button will pause the capture session long enough to load the objects if it is currently running, and then set it back to run. If the Motion Capture was paused, it will remain paused after a Quick Load operation.

Local Objects & System Objects

There are two object lists in the Output Panel: The Local Objects list and the System Objects list. The Local Objects list contains a list of all MarkerSet files (.mars, .prop, .prj) which can be loaded from the current working folder. The System Objects list contains MarkerSet files that can be loaded from the UserFiles\SystemObjects folder. To load a file, just click on it to check the box next to the file name. It is important to note that two MarkerSets with the same name can not be loaded at the same time.

Each object list has three buttons, which allow selecting all the files, deselecting all the files, and refreshing the file list. The 'red X' button allows selected files to be permanently deleted from the hard disk. Each list also has an arrow button. This is used to copy a MarkerSet from one location to the other. After copying, the Local Object will always be the one that is loaded. This is can be a useful tool in day-to-day work flows. See the Motion Analysis Recommended work flow for more information.

Figure 7-4. Objects Panel



☐ Body.mars
☐ Club.mars
☐ SA.mars

☐ Static_CC.mars
☐ Static_HH.mars
☐ Wand500.mars

System Objects is a feature used to help track objects that are known to be rigid objects. The advantage in using this feature over using a standard objects with a Template is that rigid objects can be more robustly tracked and can have several markers define the 6 DOF Rigid Object coordinate system. This is useful for tracking and identifying props such as swords, baseball bats, and other sport accessories. To use this feature:

1. Create a capture file with just the marker names of the prop. Each prop should have its own marker set and associated capture file. There must be three or more markers for rigid bodies to work; five or more markers is recommended. Marker names do not matter when they become tracked as Rigid Objects. Linkages are not needed as Rigid Objects have implicit linkages between all markers on the

object. You can create linkages to help you visualize the prop when it is tracked if you wish but when a rigid object is identified as such, both the markers and the linkages are shown as a purple color.

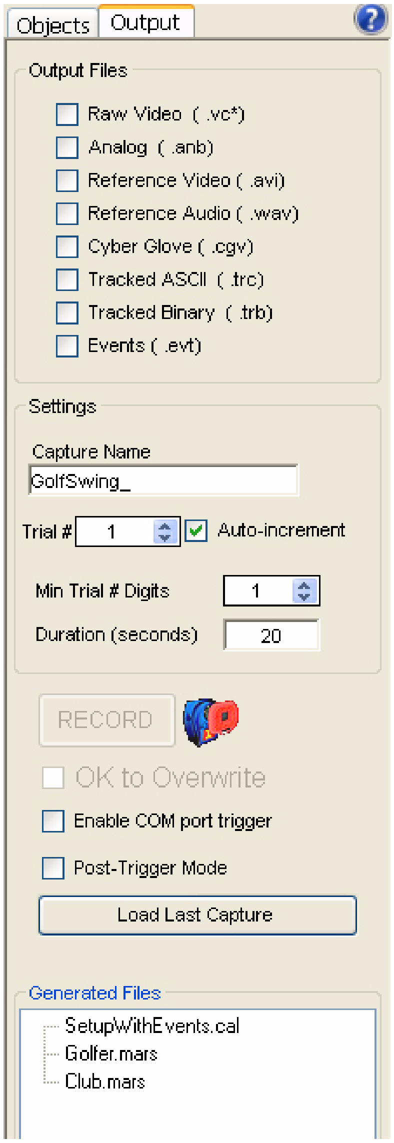
2. Create a Prop file. Record some number of frames of the prop (maybe 2-5 seconds), and then load the Tracks into Post Processing. Identify the markers and click the **Create Template** button. Select **Rigid Object** as the template type. The Create Template changes words to “Create Prop File". A message pops up telling you that you created a prop file in your current capture folder. A second message informs you that "The type will become rigid when selected on the Objects panel and that a Rigid Object Template has been created.
3. Using the prop file in you local folder, the prop file can be selected as any Tracking Object in the **Motion Capture > Objects** panel. Props can be selected as normal tracking objects and they take up one of the tracking object slots. Currently the coordinate system of the prop is displayed in the Motion Capture 3D View. When you record a trb or trc file, the XYZ coordinates of the prop are also recorded. Visually, you can see the coordinate system of the Rigid Object defined. The coordinate system displayed has the origin at the center of mass of the defining markers and the directions of the XYZ axes are defined parallel to each of the calibration coordinate system axes as defined on frame 1 of the capture.
4. Create a global System Objects folder. If you want to build a library of props, you can create a folder under the launch folder of **Cortex** (next to the Sounds folder) and name it SystemObjects (note: no space between System and Objects). Copy any props you want to use into the SystemObjects folder. You will need to quit and relaunch **Cortex** and then you will see a new section at the bottom of the **Motion Capture > Objects** panel with the heading “System Objects.” You can select prop files from that list to go into any of the "Additional Tracking Objects" slots.
5. Order the objects in the Tracking Objects panel. The priority for identifying objects is A-B-C-D-E and the Main Markerset is identified last. You will want to put the props at the beginning of the list into the top slots. Done this way, it is less likely for the props to be embedded into one of the other human objects.

Output Panel

The Output panel is used when the motion capture recording is initiated. It is set by the following procedure:

1. Choose the output file type (at least 1).
2. Enter a file name.
3. Set the file length (in time).
4. If necessary, set the external trigger mechanism.

Figure 7-5. Output Panel



Objects | Output

Output Files

☐ Raw Video (.vc*)
☐ Analog (.anb)
☐ Reference Video (.avi)
☐ Reference Audio (.wav)
☐ Cyber Glove (.cgv)
☐ Tracked ASCII (.trc)
☐ Tracked Binary (.trb)
☐ Events (.evt)

Settings

Capture Name: GolfSwing_
Trial #: 1 ☑ Auto-increment
Min Trial # Digits: 1
Duration (seconds): 20

RECORD

☐ OK to Overwrite
☐ Enable COM port trigger
☐ Post-Trigger Mode

Load Last Capture

Generated Files

SetupWithEvents.cal
Golfer.mars
Club.mars

Output Files

The Output files are the files generated during a motion capture session. This section of the Output panel allows you to choose which files are to be produced and saved in the capture file directory.

Settings

Settings allows you to provide the specifics for your generated output files. This includes the name of your files, the trial number, and the duration of the trial. The duration lets you set the length of the motion capture, so there is little wasted time in the session.

Note: VC*, ANB, AVI, WAV, CGV, TRC TRB and EVT, and TC (time code) files are all associated in the Capture by their file names. If you rename the output files, they will not be recognized in the Capture and will cause the Load Capture function to issue an error message and the Capture will not be loaded.

OK to Overwrite

This allows you to redo an existing file, once it has been saved.

Enable COM1 Trigger

When using an external trigger mechanism, you will need to check this box for the software to recognize it. You can install an external trigger by plugging it directly into your COM1 port on your Host computer.

Post Trigger Mode

When the Post Trigger Mode check box is activated, it enables the software to record the data from the end of the session, backwards based on the capture duration (X) that has been set (i.e. from the end of the data capture to –X seconds). This is useful for captures where there is no defined starting point or event, but the ending is well organized and smooth, and you would like to capture only the final moments. Note, this only works for tracked data (TRB and TRC files) and Raw Video Camera (VC) files. This does not work for analog or Reference Video files.

Load Last Capture

This button will load the last TRB file captured with the current capture file. By default, it will load TRB files first. If they don't exist (only TRC files were captured), then it will then load a TRC file.

Recording Data

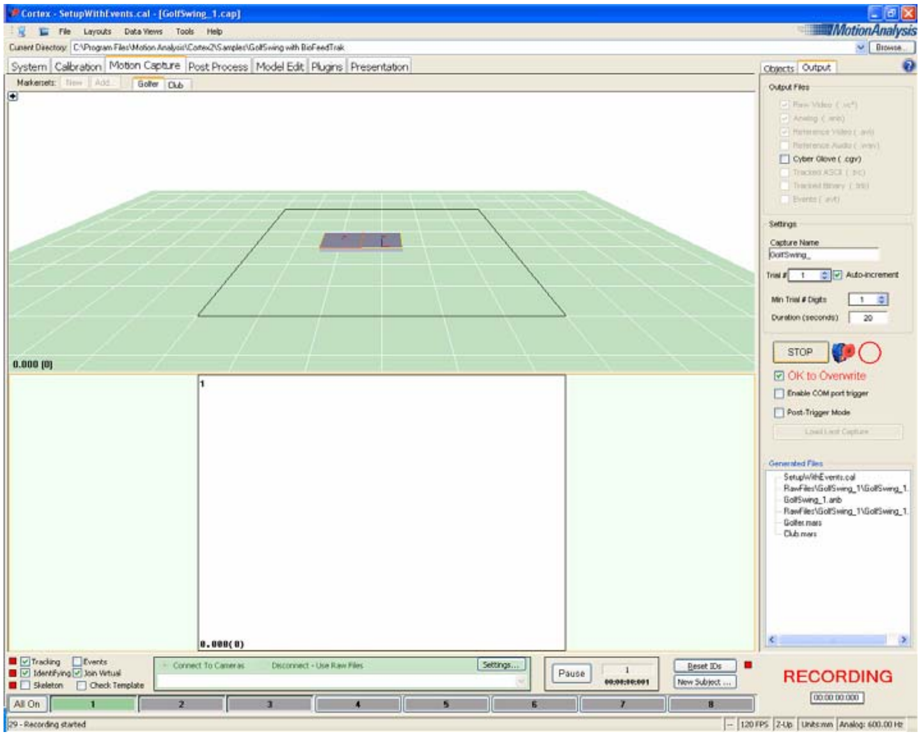
After setting up the template, always be sure to save the capture file (**File > Save Capture**). Use the following procedure to record a motion capture session.

1. Select the Output panel.
2. Select the output file types to be generated.
3. Enter a name for the file.
4. Enter a trial number. This is optional and will self increment if multiple trials of the same name are recorded.
5. Enter the estimated time length for the motion capture recording.
6. Select **Enable COM1 Trigger** if you are using an external trigger.

Note: The wireless trigger also works to toggle the record function.

7. Select **Post Trigger Mode** if you only want the last portion of your motion capture session. This function allows you to select from the end of the session, working backwards to a specified time point.
8. Click **Record**. You should see the word RECORDING in large red letters on the lower right corner of the interface. See Figure 7-6.

Figure 7-6. Recording Data


Cortex - SetupWithEvents.cal - [GolfSwing_1.cap]
MotionAnalysis
File Layouts Data Views Tools Help
Browse...
System Calibration Motion Capture Post Process Model Edit Plugins Presentation
Markersets: New Add... Golfer Club
Objects Output
Output Files
Raw Video (.vc*)
Analog (.anb)
Reference Video (.avi)
Reference Audio (.wav)
Cyber Glove (.cgv)
Tracked ASCII (.trc)
Tracked Binary (.trb)
Events (.evt)
Settings
STOP
Load Last Capture
Generated Files
Tracking Events Identifying Join Virtual Skeleton Check Template
Connect To Cameras Disconnect - Use Raw Files Settings...
Pause
Reset IDs New Subject ...
All On 1 2 3 4 5 6 7 8
RECORDING
00:00:00.000
120 FPS 2-Up Units:mm Analog: 600.00 Hz

Current Directory: C:\Program Files\Motion Analysis\Cortex2\Samples\GolfSwing with BioFeedTrak

Capture Name: GolfSwing_

Trial # 1 ☑ Auto-increment

Min Trial # Digits 1

Duration (seconds) 20

☑ OK to Overwrite

☐ Enable COM port trigger

☐ Post-Trigger Mode

SetupWithEvents.cal
RawFiles\GolfSwing_1\GolfSwing_1.
GolfSwing_1.anb
RawFiles\GolfSwing_1\GolfSwing_1.
Golfer.mars
Club.mars

29 - Recording started

9. When recording is complete, click **Load Last Capture** to replay the tracked data that was last recorded. This will automatically send you to the Post Processing mode.

Tracking Strategies and Tips

Speeding Up Tracking in Cortex

Changing the Max Speed to 30 mm/frame and the Max Prediction Error to 10 mm greatly enhances tracking for most normal speed data sets. While this needs to be adjusted up for high-speed trials, keeping a 3:1 ratio works well. This can cut your CPU load by 50% or more.

Here is what is under the hood, see the **Tools > Settings > Tracking** panel.

Max. Speed

If a marker has NO track history (i.e. a new marker just found on this frame), how big of a sphere do we draw around its current location to look for its continuation in the next frame. This should affect only startup tracks. It can affect performance if it is TOO BIG by making the software check more points than are necessary. If it is TOO SMALL, it will not create contiguous tracks; the tracks will have many holes and lots of unnamed markers.

Max. Predictor Error

Max. Predictor Error determines a sphere around the projected (extrapolated) path trajectory into the next frame. If the marker is not found in that projected sphere, it is assumed to have disappeared. This should affect only continuing tracks with a history, which is the bulk of what is being tracked. This can have a big effect on performance if it is TOO BIG. If it is TOO SMALL, tracks will be broken up into smaller path fragments and there will be an excessive amount of unnamed markers.

Bring up the Task Manager and monitor the CPU usage. You can see this with trials you have already collected by selecting the Raw Video Files you collected, click the **Run** button. Change the above Tracking Parameters, press the **Run** button again and see the difference. Check that the **Tools > Settings > Playback** panel and the Real Time speed option is selected.

Prop Files

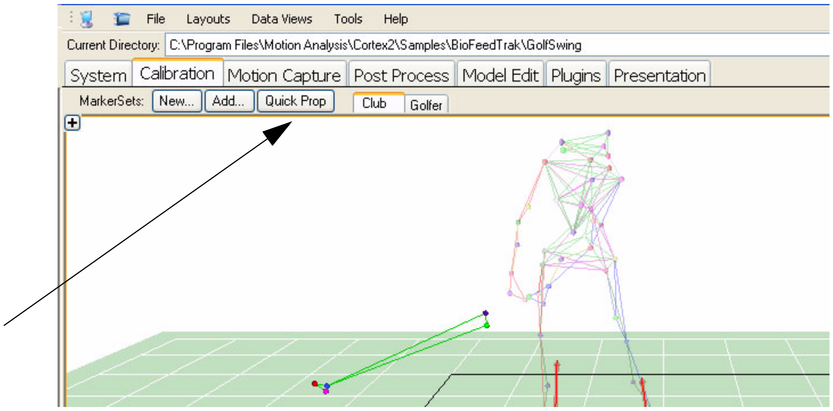
Cortex has the ability to create and store "Prop files" for props. These were introduced for the animation side software which gave them their name. An actor brought a rigid body on set: baseball bat, hockey stick, catcher's mitt, etc. They wanted to be distinct from the actor's marker set of hierarchically linked segments (bones) so the Props could be inserted and deleted quickly and easily. A new kind of identifying template has been created with an independent local coordinate system, specifically used for these Props. These are now used by other Cortex users who want a simple bone (3D coordinate system) calculated in real time and streamed to their Client SDK program(s).

Properties of Props in Cortex

1. Assumed to be a rigid body with 4 or more markers which show up as regular "named" markers. They get identified (labeled) in real time when the Tracking and Identifying boxes are checked in the Motion Capture panel.
2. Has an imbedded local coordinate system (LCS) with origin at the geometric center of mass of the markers and initial orientation defined by the placement of the prop in the field of view when the prop was created. Local coordinate system will show if Show Skeleton and Show Skeleton Axes boxes are checked with the XYZ > RGB convention of showing a coordinate system.
3. The single bone Skeleton is calculated using the Global Optimization method which is the same method as is applied to the (generally more complex multi-link) Calcium models. Translations and Rotations are reported with respect to the global coordinate system as defined by the placement and measures of the L-frame.
4. The Quick Prop button generates a prop from the selected un-named markers in the 3D view. Default marker and prop names are used which can be edited by selecting the prop in the Model Edit view. If marker ordering is important, these can also be edited in the Model Edit Tree View with the Prop selected.
5. Props are saved in their own file with the unique .prop extension. They can generally be used where ever a MarkerSet is used, including objects selectable in the **Motion Capture- > Objects** panel under the **Open Fusion Object Loader** button.
6. If you use a Prop and a MarkerSet (more than an single object), the trb and trc files you generate will have a file name that includes the Prop (or MarkerSet) name which is different from the .anb, avi or other files associated with the capture. It is also the case if you have unchecked the **Single MarkerSet legacy file naming enabled** check box in **Tools > Settings > File Structure**.

Quick Props

Figure 7-7. Quick Props Button



Current Directory: C:\Program Files\Motion Analysis\Cortex2\Samples\BioFeedTrak\GolfSwing

The Quick Prop tool is a fast and easy way of generating rigid tracking objects. This tool can be used in post processing, using pre-recorded data, or from live data without the need to record. The functionality is the same in Live Mode and Post Processing. The following example will be done running from VC files, but it would be the same if connected to cameras.

1. **Find a good data frame**—In Live Mode, press pause and scrub to a frame of data where all markers are visible.
2. **Select the unnamed markers**—Holding Ctrl, select the unnamed markers that represent the prop.
3. **Press Quick Prop**—Press the Quick Prop button the MarkerSets tab. The markers will become unselected, you will receive a status message and the prop will show in the MarkerSets list.
4. Repeat this for all the desired props.
5. **Press Run**—Once all props are created, press run to see them in action.

Finalizing

At this point all the props exist in memory. They must be saved to disk in order for them to be able to be reused at a later time. In Post Processing mode, this can be done using the Save Capture function.

Details

All the props are created with default names: QuickPropXX, where XX is a number that starts at 01. The first XX that results in a unique MarkerSet name (between Live Mode and Post Processing) is used. All markers are named M1 to MN where N is the number of Markers.

Once created, the names and other properties of the Props can be edited from the **Model Edit > TreeView** panel.

Chapter 8 Post Processing Tab

Topic	Page
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Editing Tracked Data

The **Cortex** Post Process mode allows you to play back and edit tracked data stored in TRB (binary) and TRC (ASCII) files. Markers can be identified if they have gone unnamed during the recording session. Gaps and aberrations in data can be filled or fixed by hand, frame by frame, or by employing mathematical functions across entire sections of a data set. Up to ten operations can be undone if you make a mistake, but it is recommended that you save your work frequently.

Typically, an editing session requires having both the 3D View and the XYZ Graphs open at the same time in two different Graphics Panes.

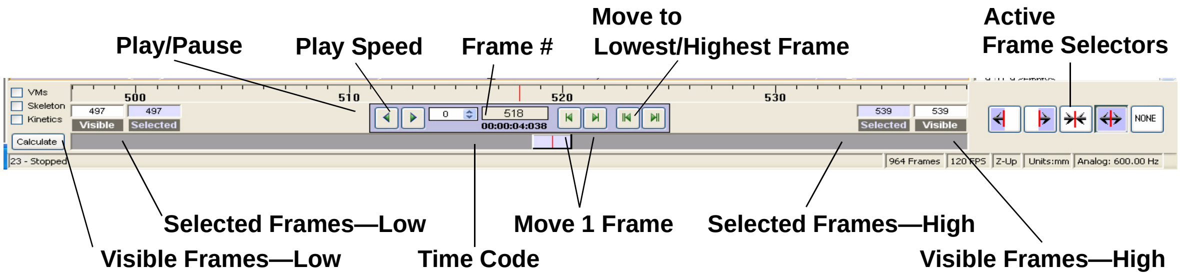
1. Click **Post Process** from the Mode Buttons.
2. From the Menu Bar, choose **Layouts > 2 Panes: Top/Bottom**.
3. Left-click in the Top Pane to select it.
4. Activate the 3D View by pressing **F3** on the keyboard of by choosing **Data Views > 3D View** from the Menu Bar.
5. Left-click on the bottom pane to select it.
6. Activate the XYZ Graphs by pressing **F4** on the keyboard of by choosing **Data Views > XYZ Graphs** from the Menu Bar. It will display X, Y, and Z tracked position data, and optionally, residuals, and the cameras that triangulated the markers.

Viewing Your Data

The XYZ Graphs will display none, any, or all markers you have selected in the Post Process tab. Selection of markers from a marker list is done with standard selection methods including **Shift** + click, **Ctrl** + click, and click + drag over the marker names. In addition, the top row of the marker list acts as a special selecting button. Markers can also be selected by simply clicking and **Ctrl** + clicking on markers in the 3D view.

The Post Process tools heavily utilize the Post Process Dashboard controls. These controls are itemized and described as follows (from left to right in Figure 8-1).

Figure 8-1. Post Process Dashboard


Play/Pause
Play Speed
Frame #
Move to Lowest/Highest Frame
Active Frame Selectors
VMs
Skeleton
Kinetics
500
510
520
530
497
497
Visible
Selected
0
518
00:00:04:038
539
539
Selected
Visible
NONE
Calculate
23 - Stopped
964 Frames
120 FPS
Z-Up
Units:mm
Analog: 600.00 Hz
Selected Frames—Low
Visible Frames—Low
Time Code
Move 1 Frame
Selected Frames—High
Visible Frames—High

Low and High Visible Frames

The Low and High Visible Frames define the lower and upper limits of the visible frame range. The Current Frame is never outside of these limits. Absolutely no identifying or editing can occur on frames outside of the visible range, with the exception of the join tools. Their values are found in the white Visible Boxes and can be changed by typing numbers into these boxes and pressing **Enter** on the keyboard.

Low and High Selected Frames

The Low and High Selected Frames are the lower and upper limits of the selected frame range. These values can be changed with a middle-click drag mouse action in the XYZ, Analog, or Skeleton Graphs panel, or by typing numbers into these boxes and pressing **Enter** on the keyboard. The Selected Frames region is shaded in light-blue. See “Joining Gaps in Data” on page 8-5 for details. When editing data in the XYZ view, only data in the Selected Frames region will be affected. Areas outside of the Selected Frames are protected from the edit steps.

Play Forward Button/Pause

The Play Forward button (default hot key is the **>** key) plays forward through the data until the end and then repeat from the beginning. This also acts as a Stop button.

Play Backward Button/Pause

The Play Backward Button (default hot key is the **<** key) plays backward through the data until the beginning and then repeat from the end. This also acts as a Stop button.

Play Speed

Sets the playback speed of the tracked data, in ratio to the number in this box. a value of 10 will play the tracked data 10 times faster than normal speed. A value of –10 will set it at 10 times slower than normal speed. The limits are 100 and –100.

Time Code

This shows the time code (HH:MM:SS) for the tracked data. If a time code reader and a time code generator are used when data is collected, the time code at recording time is shown. If no time code reader or generator is used, the time code starts at zero for each trial.

Frame Number

The Frame Number is the frame that is currently seen in the 3D View and is marked with a full height red line on the XYZ Graphs. The Current Frame number is found in the very center of the Post Process Dashboard.

Move 1 Frame Button

The Move 1 Frame Button (default hot key for forward is the **F** key, reverse is the **S** key) moves the Current Frame forward or back by one frame. This also acts as a Stop button.

Move to Lowest/ Highest Frame

This sets the current frame to the lowest or highest visible frame.

Time Zoom Slider

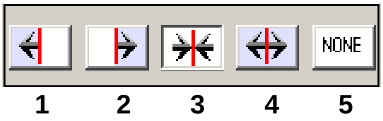
The Time Zoom Slider sets/indicates the Low and High Visible Frames. Double-clicking on this control “unzooms time” or expands the Visible frames to encompass all of the frames in the data set. If you only want to work with a specific range of frames, right-click on this slider to lock/unlock visible frames.

Selecting Frames

To the right of the Post Process Dashboard controls are five Frame Selector buttons. Refer to Figure 8-2.

1. **Select Backward** selects from the Current Frame to the Low Visible Frame.
2. **Select Forward** selects from the Current Frame to the High Visible Frame.
3. **Select Current Frame** selects only the Current Frame.
4. **Select Visible Frames** selects from the Low Visible Frame to the High Visible Frame.
5. **Select None Safe Mode**—nothing is selected.

Figure 8-2. Selecting Frames Buttons



Clicking any one of these buttons sets the Frame Selector mode that you can return to at any time by pressing **Esc** on the keyboard. The Frame Selector mode is a User Preference. The default mode is Select Visible Frames. This will also highlight the selected area in blue.

Editing XYZ data is only done in the Selected Frames. The frames outside of the Selected Frames are protected.

Zoom In-Zoom Out

The XYZ Graphs right mouse pop-up menu includes the time zooming features (default hot keys are the **I** and **O** keys). These features zoom in time (frames) centering on the Current Frame. Zooming occurs more quickly by using the hot keys.

The best way to zoom into a particular set of frames is to select the frames in the XYZ Graphs by dragging with the middle mouse and then pressing the Zoom In Hot Key. Even finer control over zooming can be accomplished by pressing **Shift** + middle-clicking to independently set the Low and High Selected Frames and then pressing the Zoom In hot key (**I**).

The XYZ Graphs also allows you to translate the data vertically and horizontally. This is accomplished by holding the **Alt** key while clicking and dragging the cursor inside the X, Y, or Z display.

It is often helpful to zoom into the data's amplitude. Holding the **Alt** key and simultaneously pressing the left and middle mouse buttons zooms the data's amplitude. The marker that was closest to the pixel on the display where zooming began becomes the Target Marker. Its data is centered either to the data in the Current Frame or optionally to the data in the frame that the cursor was on when zooming began. Data for this marker will remain centered on the screen at all times unless you forcibly translate it off the screen using **Alt** + click and drag.

Unzoom is a means of resetting the display such that zoom and translate values are equal to zero. The default Hot Key is **U** on the keyboard and it is an XYZ Graphs right mouse pop-up menu item.

Target Marker

Picking a marker out of a crowd of data is done by double-clicking directly on a marker's data line. This action will deselect all other markers leaving only the display of the Target Marker.

Scaling

Other important view options that are general in nature are described here. These options can only be accessed as XYZ Graphs right mouse pop-up menu items.

- **Auto Scale** dynamically scales the display to accommodate data in the visible frame range.
- **Uniform Scale** the display such that X, Y, and Z conform to a uniform range.
- **Show Residuals and Cameras** shows residuals and cameras along with XYZ data.

Joining Gaps in Data

Join functions are not always confined to selected frames as a conveniencer. For example, if you select only one frame in a gap of marker data, tools intended to fill that gap will seek out appropriate endpoints to that gap, store all necessary data in an undo buffer, and effect a repair to that gap without requiring you to tediously hand select the appropriate endpoints.

The smooth function smooths data within the selected frames with a Butterworth Filter algorithm. This is a low pass (high block), two-pass, 4th order, zero phase shift filter. This data can be spikes—created by frames in which a marker has experienced an acceleration greater than or equal to a selected value, or gaps—missing data.

Manually selecting frames is done by dragging the mouse in the XYZ Graphs with the middle mouse button pressed. Low and High Selected Frames can be independently picked by pressing the **Shift** key and middle clicking on the XYZ Graphs.

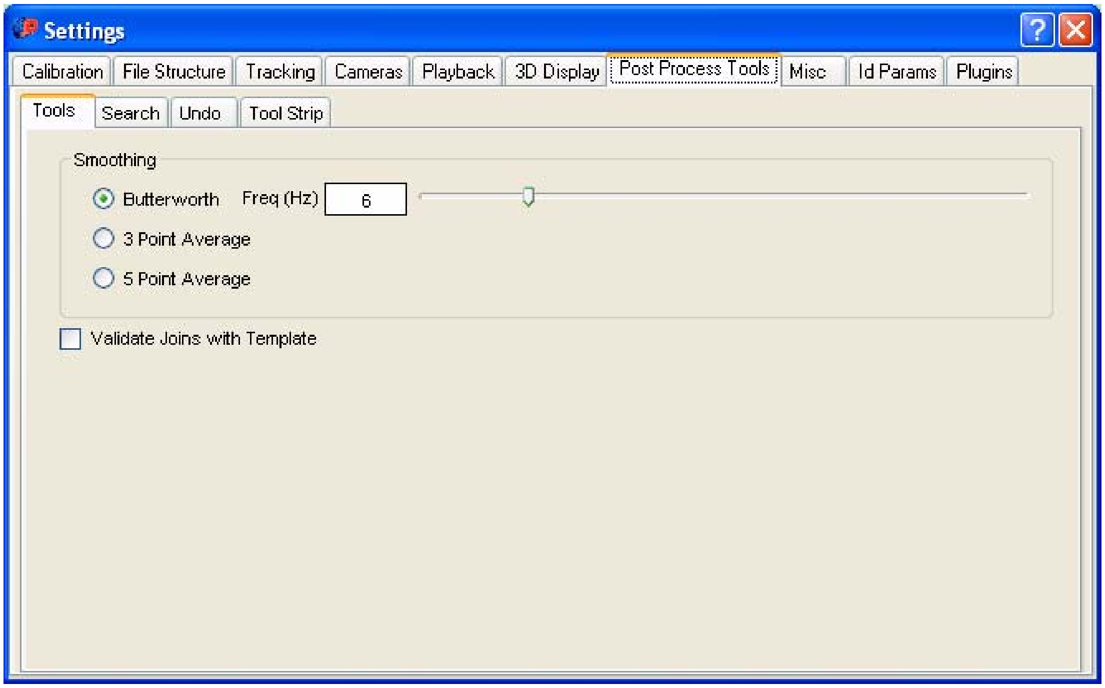
Select All Frames (default Hot Key is the **A** key.) displays and selects all frames in the data set. This is also a right mouse menu item on the XYZ Graphs.

Filters

All Motion Analysis digital cameras generate extremely clean, noise free data. For the majority of data captures, it is never necessary to modify the data by filtering or smoothing. Occasionally, however, it is useful to remove artifacts in the motion capture data. This can happen in the case of captures which contain a high number of marker occlusions or a large amount of marker merging (as it frequently happens with face tracking, for example).

For these purposes **Cortex** provides 3 different smoothing filters that can be applied to tracking data. Each filter affects only the currently selected markers over the currently selected sample range. All three dimensions (X, Y and Z) of each marker are smoothed. To access the options dialog, select the **Post Process > Options...** button.

Figure 8-3. Tools > Settings > Post Process Tools > Tools Tab



Settings
Calibration
File Structure
Tracking
Cameras
Playback
3D Display
Post Process Tools
Misc
Id Params
Plugins
Tools
Search
Undo
Tool Strip
Smoothing

● Butterworth Freq (Hz) 6

○ 3 Point Average

○ 5 Point Average

☐ Validate Joins with Template

Butterworth Filter

The Butterworth filter is a low band-pass filter with excellent mathematical characteristics for biomechanical motion. The purpose is to remove high frequency motions (motions that are too fast for a person to actually perform) while leaving intact the frequencies of motion normal to human movement. The user has the choice of selecting how aggressively the filter will smooth the motion by choosing a frequency value. Lower values will cause a very smooth result while higher values will remain truer to the original data.

Figure 8-4. An Example of Original, Unfiltered Data with Some Unwanted Error

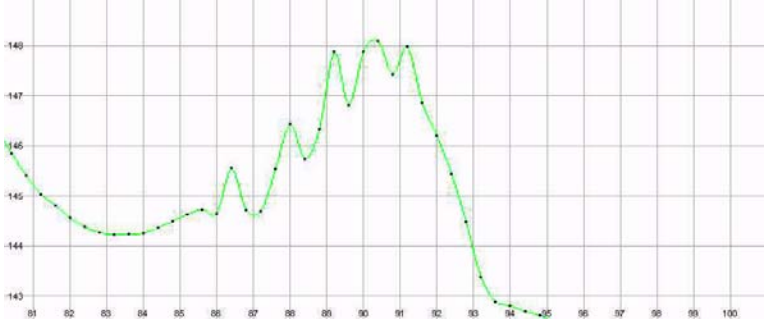


Figure 8-5. The Curve After an Application of the Butterworth Filter, with an Input Freq. of 3

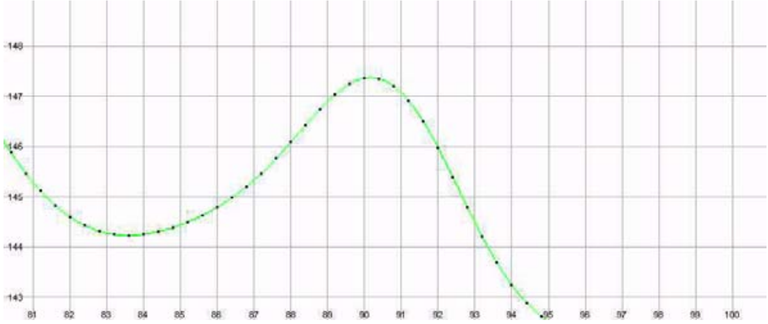


Figure 8-6. The Curve After an Application of the Butterworth Filter, with an Input Freq. of 6

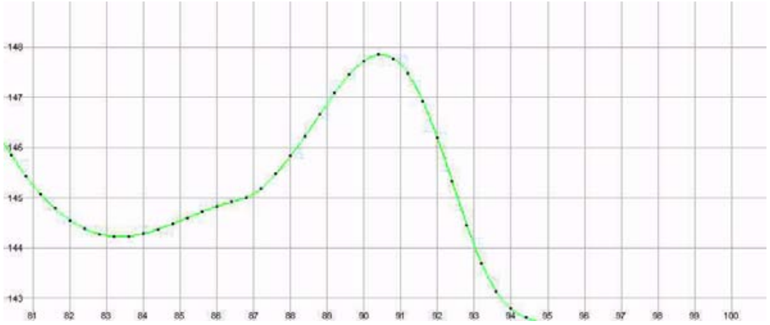


Figure 8-7. The Curve After an Application of the Butterworth Filter, with an Input Freq. of 12

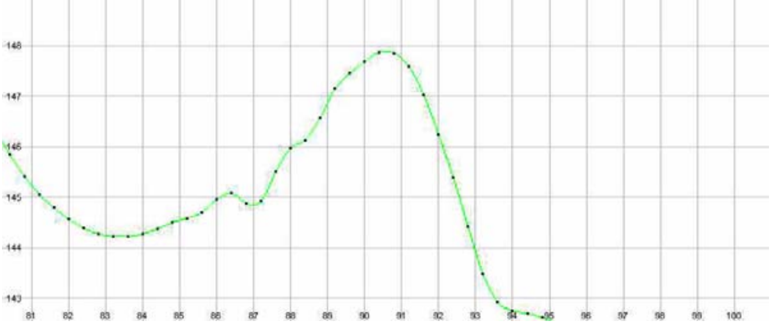
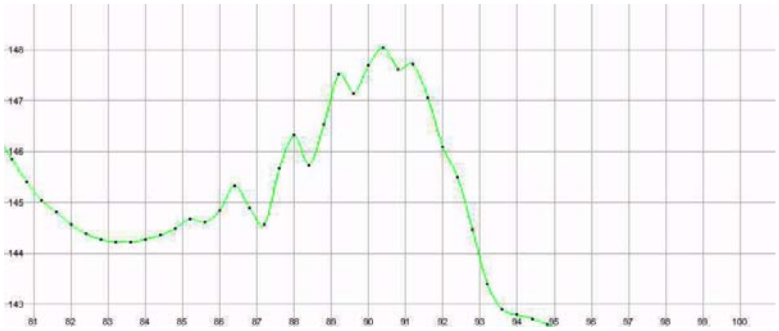


Figure 8-8. The Curve After an Application of the Butterworth Filter, with an Input Freq. of 18



As the previous sequence of images shows, the input value to the Butterworth filter noticeably changes the result. The first example, a frequency input of 3, shows a lot of smoothing applied to the curve while the last example shows very little change to the curve. Depending on your needs, these might be appropriate levels of change. For most purposes, however, values between 6 and 12 work very well as can be seen in the middle two images. In these two examples, the noisy part of the data has been removed while the overall characteristics of motion have been retained.

Details of the Butterworth Implementation in Cortex:

The Butterworth filter does have that complexity of having to use "extra data" at the end points.

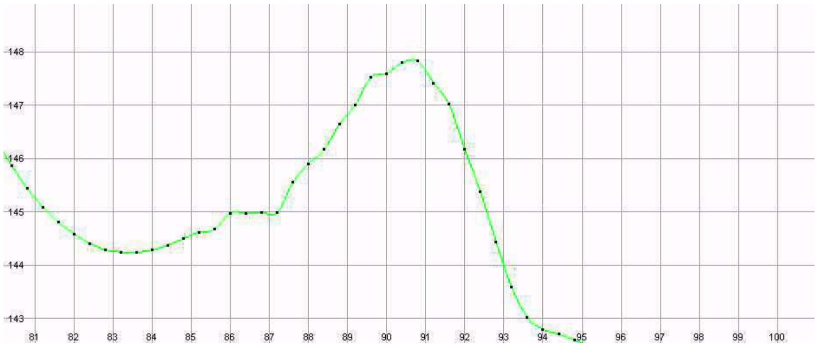
The steps are

1. Linearly transform the data to be filtered so that the first and last points are zero (0).
2. Double the number of points to be filtered. The data goes into the middle (2/4, 3/4).
3. Mirror image the first half of the data into the first quarter of the expanded points.
4. Mirror image the second half of the data into the fourth quarter of the expanded points.
5. Finally, run the two pass, fourth order filtering and then restore the data through the inverse transform done in step 1.

3-Point Average and 5-Point Average Filters

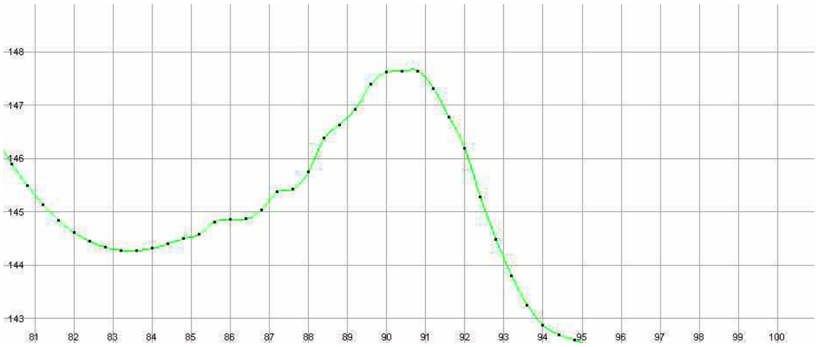
Two other filters, the 3 Point Average and the 5 Point Average filter are provided as an alternative to the Butterworth filter. In some circumstances (particularly with facial data), these can provide better results. The 3 Point Average smooths the data by taking a data point on either side of a given, original data point and averaging their values into the original one to create a new data value for that sample. This filter provides a moderate amount of smoothing as shown below:

Figure 8-9. The Curve After an Application of the 3 Point Average Filter



The 5 Point Average filter works just like the 3 Point Average filter except that it uses 2 data points on either side of the original data point to produce a new value. Since the width of the filter is wider the results are more aggressive which creates more smoothing, as seen here:

Figure 8-10. The Curve After an Application of the 5-Point Average Filter



The type of smoothing you choose depends on your needs and how much (and in what way) you want to change your data. It is perfectly reasonable to make successive applications of the filter(s) to affect the data in various ways. The number of possible combinations are extremely high so some experimentation will be necessary to find the right one for you.

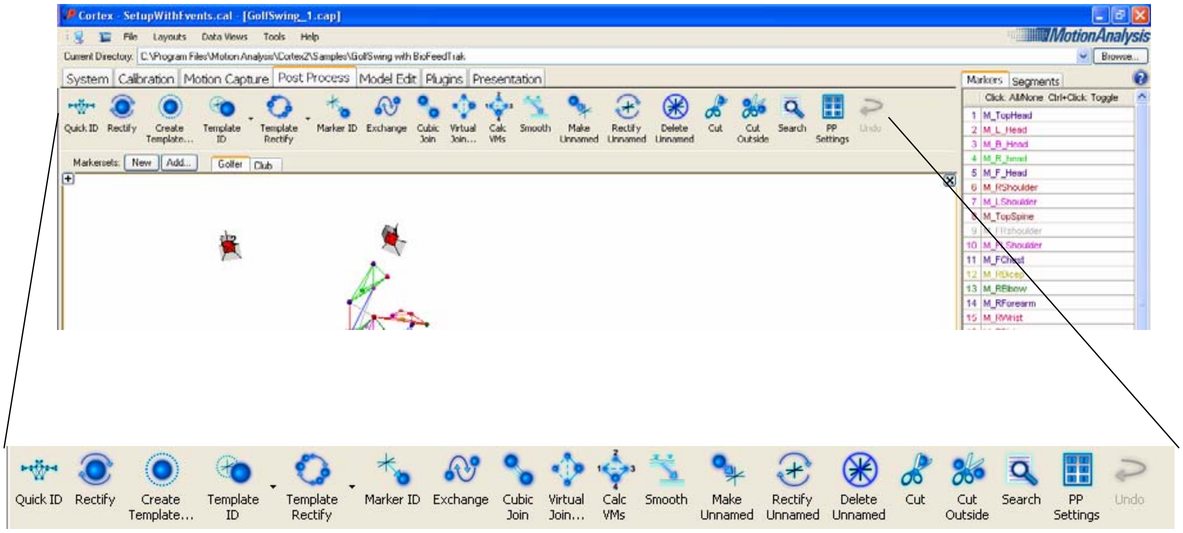
Unnamed Markers

Unnamed markers are defined as unidentified markers that are either real or not real. Some unnamed markers represent good data, yet were unidentified during a motion capture session. Others are called ghost markers and should be deleted. Ghost markers can also be removed from future data captures by going to the Tracking panel in Motion Capture, and setting the **Min. Cameras to Use** (minimum number of cameras to use) to **3**.

Note: Caution should be taken here as this process may also eliminate good data.

Post Process Tool Strip

Figure 8-11. Post Process Tool Strip


Cortex - SetupWithEvents.cal - [GolfSwing_1.cap]
File
Layouts
Data Views
Tools
Help
MotionAnalysis
Current Directory:
Browse...
System
Calibration
Motion Capture
Post Process
Model Edit
Plugins
Presentation
Markers
Segments
Markersets:
New
Add...
Golfer
Club
Quick ID
Rectify
Create Template...
Template ID
Template Rectify
Marker ID
Exchange
Cubic Join
Virtual Join...
Calc VMs
Smooth
Make Unnamed
Rectify Unnamed
Delete Unnamed
Cut
Cut Outside
Search
PP Settings
Undo

All of the Identifying tools are accessible using hot keys, panel buttons, and right mouse menu items on the 3D View and XYZ Graphs.

Note: You can rearrange, add, and delete the icons by right-clicking on the Post Process Tool Strip. To move the icon to a different location on the Tool Strip, press the **Alt + Left-Mouse** button and drag it to the new location. The Tool Strip order is remembered the next time **Cortex** is launched, allowing for user customizing and convenience. Also, any of these functions can be stored and accessed under Hot Keys.

Default Icons

The following are the default icons as set by the initial installation of the Cortex software.

Quick ID

Identifies the selected marker, identifying all markers one by one, according to the list. It will normally select with auto incrementation (auto increment).

The user identifies the markers in the MarkerSet list, one marker at a time from the top of the list.

The marker list will auto-increment after a marker is identified.

Rectify

Re-identifies missing markers (gaps) in a determined frame range. For more information on the Rectify functions, refer to “Rectify Functions: What They Do and When To Use Them” on page 8-19.

It is also used for cleaning up the Initial Pose for making a template when you have no template to start with. Takes ALL markers on the current frame (regardless of the All vs. Selected radial button), measures the linkages on the current frame and uses those measures to automatically sort markers into the correct marker slots.

Characteristics of Rectify:

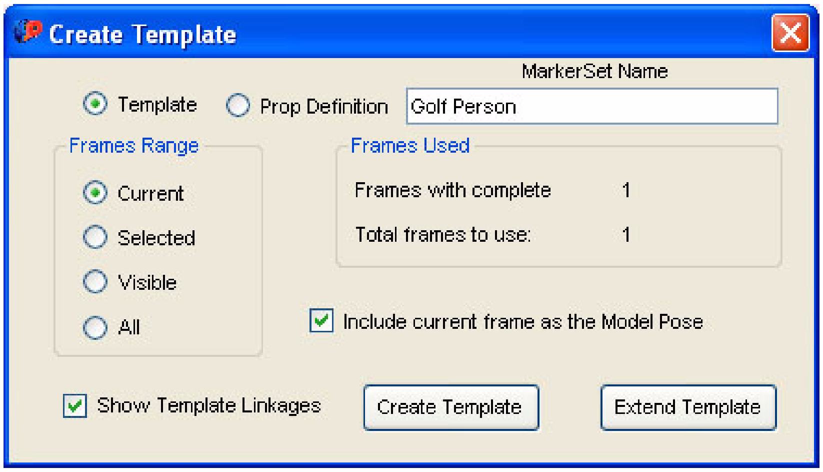
- Uses all markers, Named and Un-named
- Works only on the Highlighted XYZ Selected Time Range
- Uses the Named marker linkages and XYZ path continuity
- It will switch Named markers (Named markers are not automatically locked)
- Adjusts Linkage lengths dynamically to fit the data (including mistakes)
- Uses the **Tools > Settings > Identifying Parameters** function (typical)

Template Create...

A template for identification can be created which will be used to auto ID markers in Real Time, for Template ID, and Template Rectify.

For more information, refer to “Building a Template” on page 9-5.

Figure 8-12. Create Template Interface



MarkerSet Name: Golf Person

● Template ○ Prop Definition

Frames Range
● Current
○ Selected
○ Visible
○ All

Frames Used
Frames with complete 1
Total frames to use: 1

☑ Include current frame as the Model Pose

☑ Show Template Linkages

Template Create Button in Post Processing with Template Selected

MarkerSet Name—This is the name found in the Model Edit TreeView and can be turned on and off in the 3D Display Show Properties check box “MarkerSet Names”. It is used for the display and for having unique names when you are tracking multiple objects.

Include Current Frame as the Model Pose—The Model Pose can be turned on and off in the 3D Display Show Properties check box. It is used functionally for two things in the **Cortex** software.

1. Identifying the template when the **Motion Capture > New Subject…** dialog box is showing
2. For showing the Model pose when manually fitting the Calcium segments within the marker cloud for the Calcium Skeleton in the Model Edit panel.

Template Create Button in Post Processing with Prop Definition Selected

Include Current Frame as the Model Pose—Check for display purposes only; not used in the calculations.

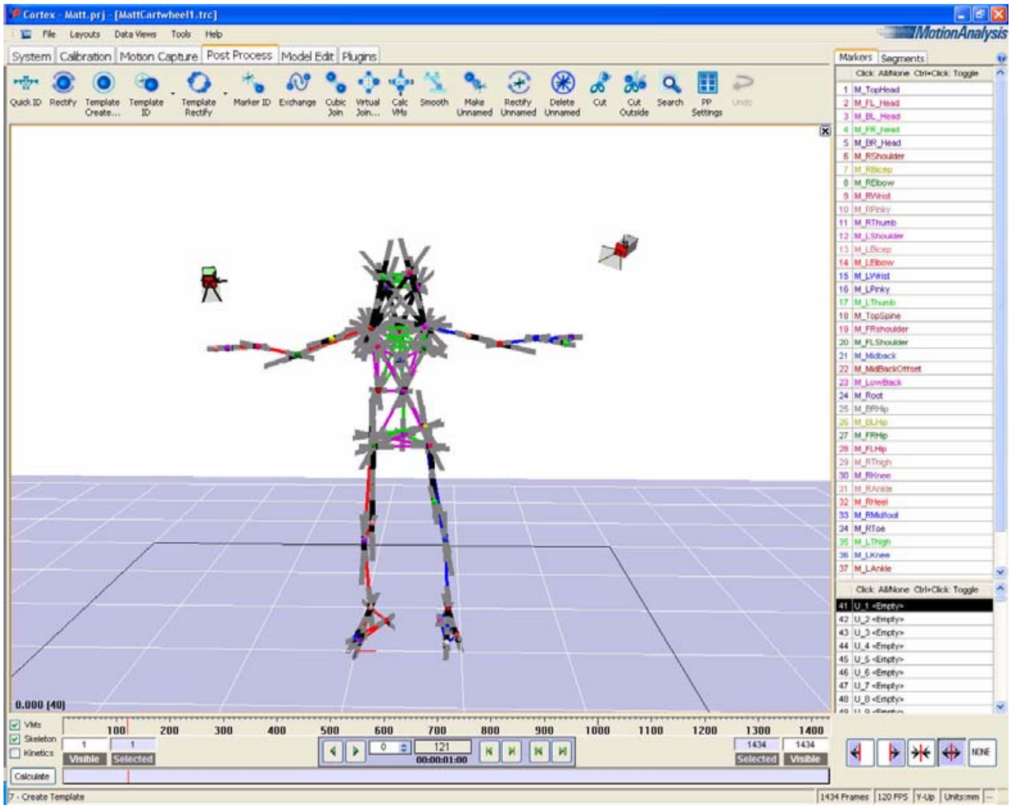
MarkerSet Name—A .prop file is created when you press Create Prop File in the current data folder. The Prop file can be used as an “Additional Tracking Object” in the **Motion Capture > Objects** panel. A prop is tracked as a rigid body and the 6 degrees of freedom. The prop is displayed in the 3D Display window and streamed to the SDK interface as a 6 DOF segment that is reported with respect to the Global Coordinate System defined by the L-frame calibration.

Show Template Linkages

This option selects all linkages and displays them in the following manner:

- Black parts represent measured linkage information for use with the Identifying Template for Template ID and Template Rectify. This is set or extended when you Create or Extend the Template.
- Grey Parts represent the “Extra Stretch” used by the Template ID and Template Rectify. This is set in the **Model Edit > TreeView-Links**. You can set individual links or groups of links.
- When you create a new link in the **Model Edit > Markers Panel**, the default values for the Extra Stretch is 15%, can be changed in **Model Edit > TreeView**.
- For compatibility with previous versions of **EVaRT** software, project files with undefined templates were always given extra stretch values of 0.30 (30%), which is larger than is now optimal. Reading older project files with undefined links will be given Extra Stretch value of 0.30 and can be changed by the user selecting those links, setting the Extra Stretch and saving the file.

Figure 8-13. Show Template Linkages


Cortex - Matt.prj - [MattCartwheel1.trc]
File
Layouts
Data Views
Tools
Help
MotionAnalysis
System
Calibration
Motion Capture
Post Process
Model Edit
Plugins
Quick ID
Rectify
Template Create...
Template ID
Template Rectify
Marker ID
Exchange
Cubic Join
Virtual Join...
Calc VMs
Smooth
Make Unnamed
Rectify Unnamed
Delete Unnamed
Cut
Cut Outside
Search
PP Settings
Undo
Markers
Segments
0.000 (40)
VMs
Skeleton
Kinetics
Calculate
Visible
Selected
1434 Frames
120 FPS
Y-Up
Units:mm
7 - Create Template

This “feathered stick figure” can be used to look for possible problems in the template such as:

- Asymmetry—Unless the person is doing asymmetric activities, the template should be fairly symmetric in both the black and grey bands.
- Black lines that are too long—This can be caused from a mis-identified marker or a marker switch that got measured and stored in the template with the Create Template or Extend Template functions.

Template ID

Uses the template to ID all markers in the current frame.

All Markers Pull Down Selection

Allows you to select all markers at once for Identifying.

Selected Markers Pull Down Selection

Allows you to select specific markers for Identifying.

Template Rectify

Uses the defined template and identified current frame to ID markers over the selected frames.

Option: All or selected markers.

Marker ID

The user selects a marker in the marker set list to identify that marker in the 3D view. Marker ID is the same as Quick ID, without the auto increment feature.

Exchange

Exchanges the 3D positions of two selected markers.

Exchange requires that exactly two markers are selected. The data is exchanged between the markers within the selected frames.

Cubic Join

Calculates the values to place in the gaps with a cubic spline. If you manually select the endpoints of the gap before executing the join, the function will fill the gap with a linear interpolation because the second derivative at the endpoints equals zero.

Join Linear

Selecting this will automatically fill a gap in selected frames of the XYZ marker data with linearly interpolated data.

Virtual Join

The assigned Virtual Join definitions will be applied to XYZ marker data for the selected markers over the selected frames. For all information regarding Join Virtual, refer to See “Join Virtual” on page 8-24.

Calculate Virtual Markers

This calculates the locations for all assigned virtual markers over the selected frames. For more information, refer to "For complete information on Calcium software and Calcium segment definitions, please reference the Calcium for Cortex Quick-Start Guide (p/n 651-1920-010)." on page 9-24.

Smooth

Smooths data within the set frames with the selected filter type. A Butterworth, 3-point moving average, or 5-point moving average filter can be applied to the selected markers over the selected frames. Filter selection is found in the **Tools > Settings > Post Process Tools > Smoothing** form. For more information, refer to "Filters" on page 8-5.

Make Unnamed

The selected marker(s) will become unidentified over the selected frames.

When selected, the marker's data will be moved to the first available unidentified marker slot.

Rectify Unnamed

Makes all unnamed/unidentified markers into contiguous paths to follow through the capture sequence. For more information on the Rectify functions, refer to "Rectify Functions: What They Do and When To Use Them" on page 8-19.

Delete Unnamed

Deletes all unnamed markers over all frames.

Cut

XYZ marker data within the selected frames, including endpoints, will be cut out and is available for Paste.

Cut Outside

Cuts the data outside of the selected frames exclusive of the endpoints.

Search

Finds gaps and/or spikes throughout the data set. The current frame will be set to the first gap or spike found in either the first selected marker on the marker list or all of the markers. See the **Tools > Settings > Post Process Tools > Smoothing** tab.

The Acceleration at Spikes function will indicate the frames in which a marker has experienced an acceleration greater than or equal to the selected value. The indicator appears as a carat (V) at the top of the XYZ Graphs.

PP Settings

The PP Settings button opens a form that lets you set the following:

1. Tools > Smoothing—filter type
2. Search—gaps and/or spikes
3. Undo Buffer—enable or disable Undo Buffer for data editing
4. Tool Strip—Customize Post Process Tool Strip

Undo

Undo retrieves data affected by the most recent data Edit or ID function and places it back into the data set. **Cortex** supports ten levels of undo. This feature can be disabled or cleared on the Post Options form. If you get the message that an Undo function may not execute, you may need to clean your Undo buffer. This can be found in the **Tools > Settings > Post Process Tools > Undo** tab.

The Memory Gauge lets you know when you computer is running out of memory to store edits in the undo buffer.

Additional Icons

Hide Markers

Hides selected marker(s) from the 3D view.

Hidden markers will have an **(H)** in front of the marker name in the marker set list.

Unhide Markers

Unhides the hidden selected 3D view markers. This is always the default setting for new markers

Rigid Body Rectify

Uses the selected markers to ID unnamed markers through the capture sequence. For more information on the Rectify functions, refer to “Rectify Functions: What They Do and When To Use Them” on page 8-19.

Rigid Body Rectify and Template Rectify assume that all the current marker identifications are correct. They are intended for continuing the identification process without undoing previous work.

Rigid Body Rectify is a tool that could be considered a "stand-alone" tool. It does not use anything from the marker set definition at all. When the tool is activated:

1. The three, or more, selected markers are dynamically turned into a "Rigid Body" definition and measured
2. The previous frame and the current frame are then used to predict the next frame
3. Identify the frame

This stops when less than three markers of the original selected markers is identified.

Note: If one or more markers are already correctly identified, then that can help prevent errors.

This has been used to identify the entire body.

1. Select ALL the markers (minus the obscured ones). The starting frame must be identified manually.
2. Press **Rigid Body Rectify**
3. Go forward to the frame where the misidentification occurred
4. Make unnamed
5. Repeat steps 2 through 5.

Copy

Data within the selected frames, including endpoints, will be copied and available for Paste.

Paste

Cut or copied XYZ marker data will be inserted into the data set beginning with the current frame.

Rigid Body Join

The rigid body join feature has been created for rigid objects with 4 or more markers per segment. For rigid or semi-rigid objects such as swords, spears, head markers, torso markers, multiple markers on a basketball, it is convenient to use this feature to join across missing marker data. You must select a starting frame where all markers that you select are all present and part of a rigid body. You then select a range of frames on which you wish this to operate. Select **Rigid Body Join** and it automatically joins across the missing marker data.

Rectify Functions: What They Do and When To Use Them

There are three main Rectify tools for naming markers and propagating the names through time (Rectify, Rectify Unnamed, and Rigid Body Rectify). They are not for generating XYZ data from the 2D camera views, which we call Tracking, but they are very useful for Identifying the tracks or markers. Rectify means to “make right” or “set right”. All of the Rectify functions start at the Current frame and go forward in time first, then backwards from the current frame. For more information, reference these functions in the Post Process Tool Strip section starting on page 8-11.

Template Rectify

In Post Processing, use this when you have a reasonably good template. Work from known good frames into unknown and difficult frame ranges. Uses the template from the Create Template item. A template can be of one or more frames, should represent characteristic motions to be seen between markers, and is a measure of the min. and max. linkage lengths for Named markers.

The characteristics of Template Rectify are as follows:

- Uses only the Template information to move markers from the Unnamed slots to the Named slots
- Uses All Markers or Selected Markers according to the settings.
- Works only on the highlighted XYZ selected time range, starting on the current frame going forward, then backward from the current frame
- Protects all named markers, will not switch them
- Works only to move Un-named markers into the Named marker slots—here, all markers are locked
- Does not use Linkage Stretch Parameters in **Motion Capture > Tracking**

Rigid Body Rectify

In Post Processing, it is used when you have bodies crashing into each other where linkage lengths can get very distorted and Template Rectify can give results which may require some editing. Rigid Body Rectify is for very tough trials where you can have the software look for a rigid body with markers on it and it tends not to make mistakes and hence does not require a lot of editing after the fact. Work from a frame with known marker IDs to difficult areas. A Rigid Body can be any set of 3 or more Selected Markers. The software measures the markers with respect to each other and looks for this pattern in the Un-named marker to automatically assign them names. It will stop if either of two conditions are met:

1. It cannot find at least 3 of the markers of the Rigid body on a frame (so use more than 3 marker if you can)
2. The measurements stretch too much

It can be re-started on a new frame if needed. The selected markers must be identified on the Starting Frame.

The characteristics of Rigid Body Rectify are as follows:

- Measures all markers in the selected Rigid Body on the Starting Frame
- Uses All or Selected Markers (mostly used for Selected Markers)
- Protects all named markers, will not switch them.
- Works only to move Un-named markers into the Named marker slots—here, all the markers are locked
- Does not use Linkage Stretch Parameters in **Motion Capture > Tracking**

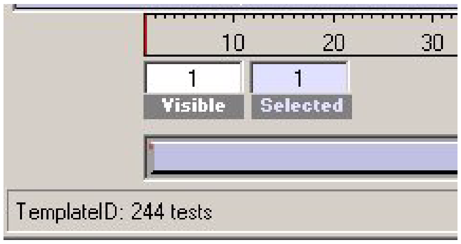
Rectify Unnamed

Rectify Unnamed sorts the Un-named slots into continuous paths based on path continuity, similar to the tracking function. No templates or linkages are used. Path segments separated by 10 or more frames are considered to be separate paths and will not necessarily be continuous. This is used to clean up the Unnamed path segments and can make the Marker ID function work more smoothly. It means you may not need the Rectify Always On check box in Marker ID and Quick ID Items. First try the Rectify Unnamed function, then try the Marker ID function for the problem areas.

Template ID

Uses the currently defined Template from Create Template to fit the linkages into the current frame’s marker cloud. If it succeeds, it tells you the number of tests on the Status Bar (lower left side of the screen) it took to complete. It may also fail or time-out, in which case you should make sure all of the markers are present on the current frame or perhaps remake your template. It only changes data on the current frame if it is successful. You can then use Template Rectify to get the correct IDs to other frames.

Figure 8-14. Template ID Details



TemplateID: 244 tests

How good is the Template? You can tell how good your template is by how many tests it takes for the Template ID function to work. A low number means it is working quickly (low is say 500). A high number (5,000 or more) means the software has to try very hard to ID the current frame. It stops trying after about 50,000 tries in Connect (Live) mode and “times out” and gives the message `Template ID: Timed out`. In Post Processing mode, it will not time out until 500,000 tries. That means it did not get to try out all possible linkages. A large number indicates a potential problem. It might be because the current frame is stretched beyond the template or in a much different actor position, or it might be because the Template is not very good. Try to use the Template ID on different frames and see if the number changes a lot. If you consistently get large numbers for the Template ID feature, try adding more links to your marker setup in the Model Edit tab.

Make triangles, especially triangles that will be fairly rigid during the movements. Lots of rigid triangles in your linkages make for solid Templates that have fast Template ID numbers. Triangles with equal sides can cause mis-IDs whereas triangles with unequal sides work much better. This will help to determine where to place markers on a person.

You must have all of the markers present on the current frame or you will get the status bar message `Template ID failed.` That means it did try out all possible linkages and could not get a match. Possibly the markers have moved or you need a better template.

Summary of When To Use What

Rectify

First, collect the trial from which you will make your template. It should be a simple trial with representative motions and not require any editing. The goal is to represent the min. and max. of each linkage in your model. Use Quick ID, then Rectify**.** If editing is required, consider taking another trial. Make sure there are no marker switches using the 3D and XYZ view, and then create a template using all of the (good) frames. Rectify may generate marker switches and you do not want those remembered in the template. It will haunt you later.

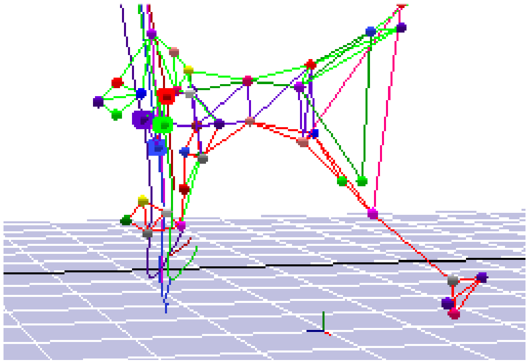
Template Rectify

For most motion trials, the use of Template Rectify will do most of the work in correctly identifying the marker tracks. Template Rectify is preferred method to use to rectify since it protects the named marker tracks: they are locked. It also keeps the template rigid and seems less likely to make mistakes. Correcting mistakes can take a lot of time. If there are some incorrectly ID-ed markers, it may be best to make all the markers Unnamed for all except the starting frame (which can be frame 1 or any other frame). To make all unnamed except frame 1, go to frame 2, select **All Markers,** then select the time range: Select **Forward**, and press **Make Unnamed** under the Identifying tab. Go back to frame 1 and press **Template Rectify.** On some complex trials where there is a crash or bang between people and or props, have the actors start in the T-pose, do the actions and return to the T-pose. You can then work the data from the start to the middle and also from the end to the middle. This working the data back and forth can save a lot of your time and not require that you hand ID many frames.

More on Templates and Template ID

After a big crash of people with markers or extreme movement, the markers may have moved and the template may not be as good. You can Extend the template by ID-ing after the crash, extend it based on one or more frames that have no mistakes, then try Template ID to see if the template holds on the new frames. Template ID tells you how good the template is working and it is the same template the Template Rectify uses. Also, think that Template Rectify gets used as much to un-identify tracks as well as identify them. If any link stretches beyond the allowable range (plus a small amount of give), then Template Rectify will cause the offending marker or markers to become unnamed, while it seems perfectly obvious to you what is right. If Template Rectify does this, manually ID that marker on that frame and Extend the Template (an option under the Create Template button). You can see this when the subject bends over and causes stretches that might not have been recorded when creating the template.

Figure 8-15. Template ID and Rectify Used for Link Stretch



Rigid Body Rectify

This takes the most time to use in that you must select a few markers and process a few frames, then repeat the process over the possibly many segments and frame sequences. If it stops, it means that the rigid body disappeared. You can re-start it again and it starts with new measurements on the starting frame. Where it is very useful is where it can slug through some tough sequences. Start with something simple, like the 3 or 4 or 5 markers on the head. As with Template Rectify, it may be best to Make Unnamed all markers on all frames if there are any mistakes in the ID-ed data. If one of the head markers is incorrectly ID-ed as a neck marker, then Rigid Body Rectify will not see that as a candidate since it only looks in the Unnamed markers list. Process the data from both ends towards the difficult part, assuming there is a “crash” in the middle and clean data on both ends. After doing Rigid Body Rectify from the starting frames to the middle, then from the ending frames to the middle, use Template Rectify to go it again. For difficult data trials, this 1-2-3-4 combination will get you a lot of named markers for very little work.

Correctly Identifying Markers Automatically: Post Processing Mode

In the **Post Process** tab, the data is identified (or re-identified) by pressing the **Template Identify** button. This affects the current frame only and it is successful if:

1. The template is good and the data fits.
2. All markers are present.

To continue the correct identification to successive frames, you need to have the Max. Speed and Max. Prediction Error settings correctly set for your data.

Max Speed (mm/frame)

This applies to when a marker first appears and is identified with the current template. To keep the correct identity into the next frame, the software checks to see if it has moved too much to be the same marker. It can move in any direction. The Max Speed parameter tells how much movement is allowed. It is measured in mm from the first frame, hence the units of mm/frame. If no marker is seen within this search sphere, then the target identify is not continued into the next frame. If a marker is found within the Max. Speed sphere, the target identity is continued into the second frame. If the number is set too small, tracking will slow down as the software tries unsuccessfully to find continuations of markers. This affects the first to second frame tracking time especially. If the number is set too big, you will see markers switch identities.

Max. Prediction Error (mm)

After a marker has a history of 2 or more frames of continuous identity in time, a track history allows the software to predict where the marker should be, based on a 2nd degree polynomial prediction. The software looks in a search radius of the Max Predictor Error about the predicted location for a continuation of each marker being tracked. The Max Prediction Error is usually set to about one-half of the Max. Speed parameter.

Join Virtual

Join Virtual is an extremely powerful editing tool used to fill gaps in marker data with simulated data based on the relationship (positional interpolation) with other markers on or near the particular problem segment. This accurately simulated information is a result of making four passes over the data in both Real Time and Post-Processing modes.

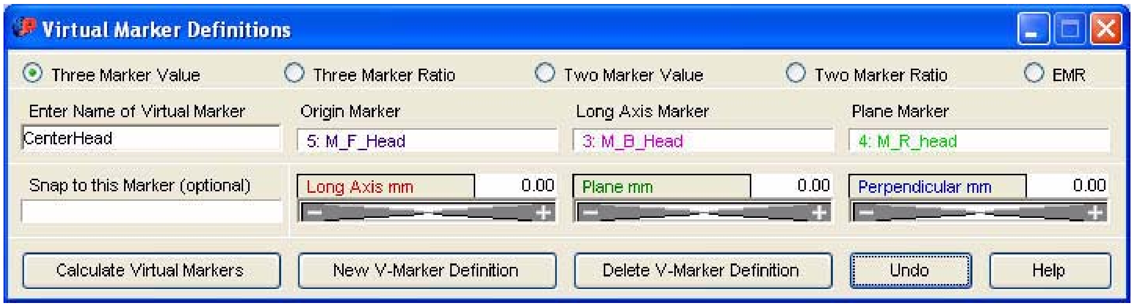
To use the Join Virtual function:

1. Find a gap within the position data of a marker. It is easiest to use the Search function (right click in XYZ Graphs and select Search).

   If you are not using the Search function, select the gap area in the XYZ Graphs (middle-click and drag) for the problem marker.

2. Select **Join Virtual** in the **Post Process** tab. Verify that the Marker to Join is set for the marker you want to edit.

Figure 8-16. Join Virtual (Virtual Marker) Definitions



Virtual Marker Definitions

● Three Marker Value ○ Three Marker Ratio ○ Two Marker Value ○ Two Marker Ratio ○ EMR

Enter Name of Virtual Marker: CenterHead

Origin Marker: 5: M_F_Head

Long Axis Marker: 3: M_B_Head

Plane Marker: 4: M_R_head

Snap to this Marker (optional):

Long Axis mm 0.00

Plane mm 0.00

Perpendicular mm 0.00

3. Click on **Origin Marker**. It will be highlighted in blue and will allow you to choose which marker to use as the marker that is most rigidly attached to the marker to join. See “Origin Marker” on page 8-25.

Note: Select markers using the 3D View or the marker grids.

4. The function will then automatically jump to the Long Axis Marker input box. Continue selecting the proper markers for each remaining input box. Make sure they are all different. You cannot have two of the same markers in the Virtual Marker Join definitions.
5. Once you have defined the three definition markers for you Virtual Marker, click on **Join Virtual**.

Note: If data is missing for any definition marker (Origin Marker, Long Axis Marker, Plane Marker) in the frame field, the gap in data will not be completely filled. You will need to select a different definition marker that has data for that frame field.

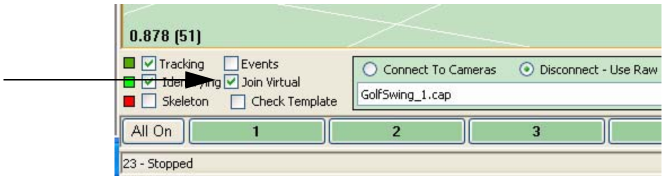
6. Repeat step 1 through step 5 for all problem markers in your data set. You may also setup the Virtual Marker definitions for as many markers as you feel will be needed, prior to capture.

7. Selecting File > Save Capture will save all Virtual Marker definitions you have set into the capture file.

Real Time Streaming with Join Virtual Fill

If you will be continuing to capture motion using the same template, the Virtual Marker Join definitions are now resident with the capture files and template. The Join Virtual check box can now be activated (on the Real Time Dashboard) allowing for Virtual Markers to be created in Real Time where data is missing for the markers you have set definitions. Thus, streamlining the editing process or post processing tasks.

Figure 8-17. Join Virtual Check Box



☑ Tracking
☐ Events
☑ Identifying
☑ Join Virtual
☐ Skeleton
☐ Check Template
○ Connect To Cameras
● Disconnect - Use Raw
GolfSwing_1.cap
23 - Stopped

The concept behind the Join Virtual and the Virtual Marker definitions are the same and are much more stable and more useful than the classic Rigid Body data filling mechanisms. The reason is that you get to choose three markers in decreasing importance that determine the replacement data. These three markers are:

1. the Origin Marker
2. the Long Axis Marker
3. the Plane Marker

Origin Marker

The Origin Marker should be the marker that is most rigidly attached to the marker to join. If there are two choices, pick the one that is more stable on the bone segment. For example, the elbow marker is a good Origin Marker. It is usually attached close to a bone. The shoulder is also good for the upper arm segment, but not as good for the upper torso if the subject raises their arms.

For segments where you have multiple markers on a rigid segment, such as the head, it does not matter which marker is which. For example, if you have four markers on the head, each of the four can be defined by any order of the other three markers. But if you have only three markers on the head, the Top_Neck marker may well be used as the Plane marker for the Join Virtual definitions.

Long Axis Marker

The Long Axis Marker defines a straight line from the Origin Marker and the Join Virtual is not sensitive to changes in the length of this line.

Long Axis Marker Example

For the left Biceps, choose the L_Elbow as the Origin, the L_Shoulder as the Long Axis Marker, and the L_ Wrist as the Plane Marker.

Plane Marker

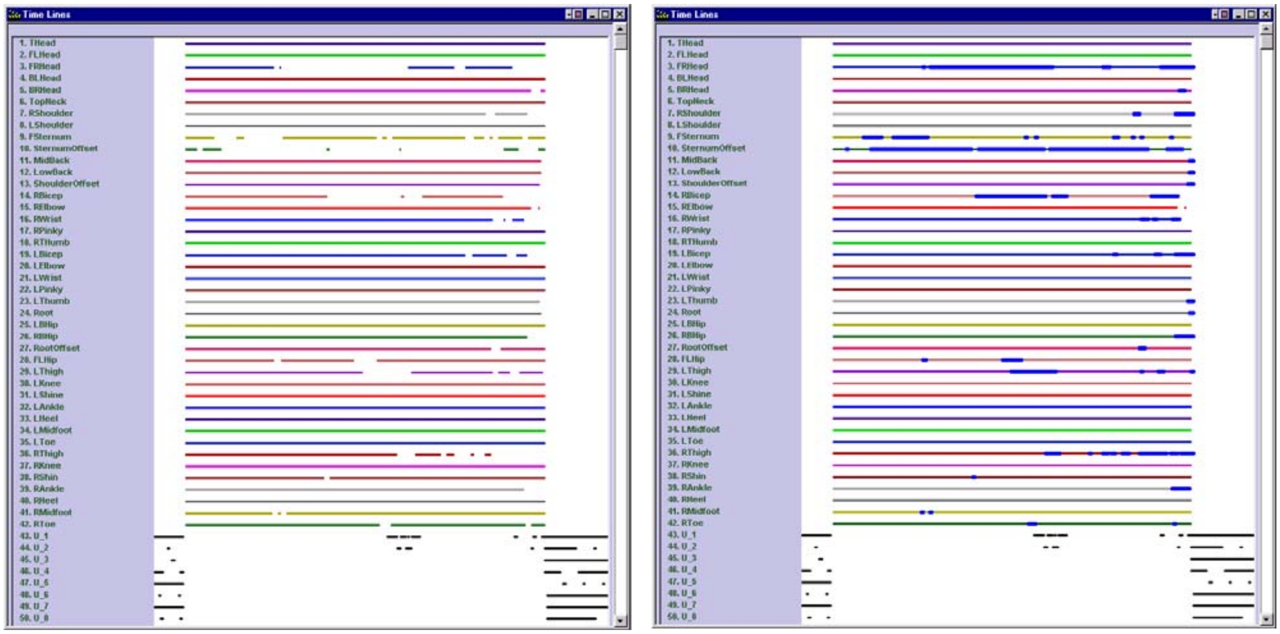
The Plane Marker is the least strongly coupled marker to the problem marker to Join. It defines only the rotation of the coordinate system located at the origin. Join Virtual and Virtual Marker calculations use the 3D offsets from the problem marker to the coordinate system's Origin Marker and apply that throughout the Join Virtual.

The results are often astoundingly good and can be used directly to speed up your animation pipelines. More study is recommended before applying these results to Biomechanics research and medical applications.

In short:

- The **Problem Marker** is the marker with the gap to be filled.
- The **Origin Marker** maintains a fixed distance to the problem marker.
- The **Long Axis Marker** defines a line to the origin marker.
- The **Plane Marker** defines a plane with the Origin and Long Axis Markers.

Figure 8-18. TRC File vs. TRB File With Join Virtual



TRC file—no Join Virtual

TRB file from same data set with Join Virtual

Time Lines
1. THead
2. FLHead
3. FRHead
4. BLHead
5. BRHead
6. TopNeck
7. RShoulder
8. LShoulder
9. FSternum
10. SternumOffset
11. MidBack
12. LowBack
13. ShoulderOffset
14. RBicep
15. RElbow
16. RWrist
17. RPinky
18. RThumb
19. LBicep
20. LElbow
21. LWrist
22. LPinky
23. LThumb
24. Root
25. LBHip
26. RBHip
27. RootOffset
28. FLHip
29. LThigh
30. LKnee
31. LShine
32. LAnkle
33. LHeel
34. LMidfoot
35. LToe
36. RThigh
37. RKnee
38. RShin
39. RAnkle
40. RHeel
41. RMidfoot
42. RToe
43. U_1
44. U_2
45. U_3
46. U_4
47. U_5
48. U_6
49. U_7
50. U_8
Time Lines
1. THead
2. FLHead
3. FRHead
4. BLHead
5. BRHead
6. TopNeck
7. RShoulder
8. LShoulder
9. FSternum
10. SternumOffset
11. MidBack
12. LowBack
13. ShoulderOffset
14. RBicep
15. RElbow
16. RWrist
17. RPinky
18. RThumb
19. LBicep
20. LElbow
21. LWrist
22. LPinky
23. LThumb
24. Root
25. LBHip
26. RBHip
27. RootOffset
28. FLHip
29. LThigh
30. LKnee
31. LShine
32. LAnkle
33. LHeel
34. LMidfoot
35. LToe
36. RThigh
37. RKnee
38. RShin
39. RAnkle
40. RHeel
41. RMidfoot
42. RToe
43. U_1
44. U_2
45. U_3
46. U_4
47. U_5
48. U_6
49. U_7
50. U_8

To test the operation of this feature, define a Virtual Marker Join for the RHip marker based on 3 others that will remain visible. Cover the RHip marker (for example) and see if it appears in the 3D view. This can be done with a live person very easily, but if you do not have a setup available, go to the 2D view of a trial, mask out enough regions and cameras so that the RHip is no longer visible. It should appear in the 3D view if you turn on the Join Virtual feature.

Both the streaming and the post-process Join Virtual use a two-pass process to virtually join data across gaps. The data passes through the Virtual Marker Join function twice, with the second pass using filled or partially filled gaps that were not filled the first time.

Join Virtual Guidelines

Note: These guidelines are intended for an audience with a good knowledge of motion capture theory and practice. These are generalized guidelines only. Individuals may find that different definitions may work better for their particular applications.

For best results, it is recommended that you have at least three markers per effected segment. Ideally, for markers that have the possibility to become obscured (i.e. being covered up or lost between the ground and the subject's body) you will need to place markers on the opposite side of the appendage or body. For example, if a subject is laying prone on the floor, the back markers become obscured. If you anticipate this, you can apply more markers to the chest or front torso area.

For defining virtual markers, when possible, define and use markers that are always seen on that segment or neighboring segments.

If any data is missing from other markers in that segment, the original data will improve, but only if the dependent markers are present.

Head

A subject's head usually will have four or five markers. Missing marker data for the head is joined using Join Virtual definitions with any three of the other markers.

Upper Arm or Upper Leg

Typically the upper arm segment is defined by three markers: Elbow, Biceps, and Shoulder. Ideally, a fourth marker on the Triceps would be present. If not, a marker on the forearm can be used as the plane marker for Join Virtual data.

If the shoulder data is missing, you may use the markers for the top of the neck, sternum, or mid-back to calculate the Virtual Marker data for the shoulder.

Hand or Foot

If you know of movements that are going to obscure the markers on a hand or foot, you may want to set redundant markers on that particular segment.

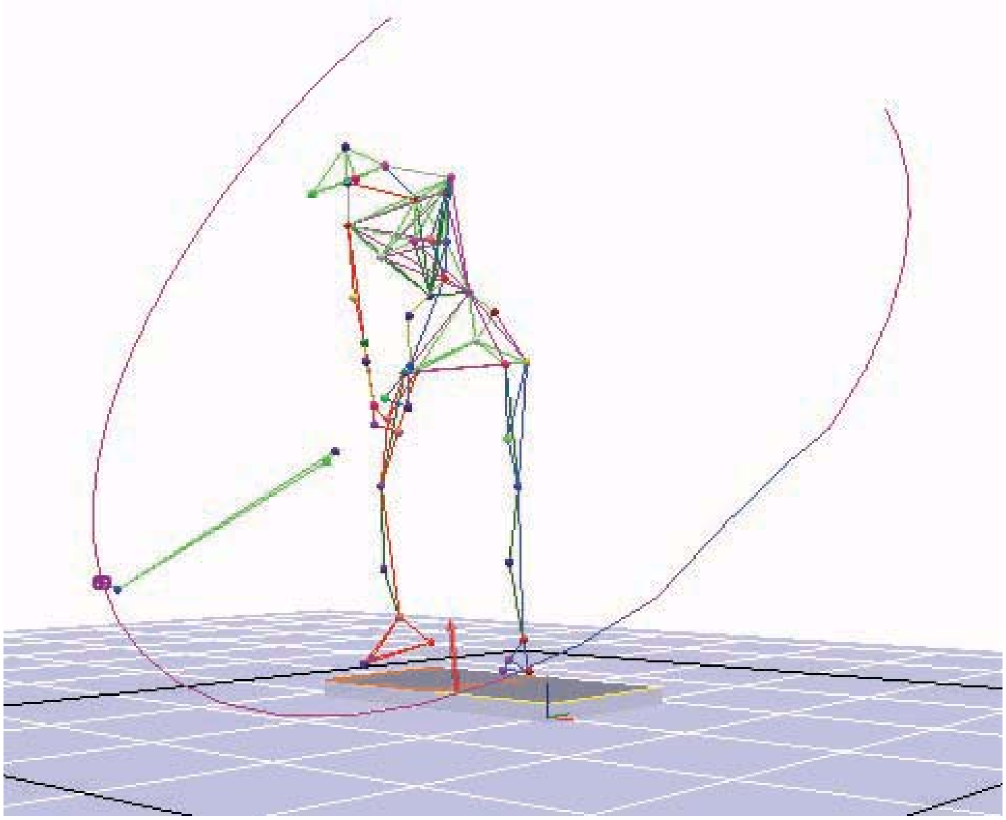
For example, if all lateral side markers on a foot are obscured from a subject laying down in a prone position, you may apply redundant markers to the medial side to provide the data for that segment.

The hand will use the same technique, with maybe a few less redundant markers on the opposite side.

Data Painting

Data Painting allows you to directly manipulate the data in the XYZ Graphs pane. Simply press **Ctrl** + **Shift** and left-click to modify or add data directly on the screen. Since the outcome of using this feature is uncertain for each user, it should be used with care.

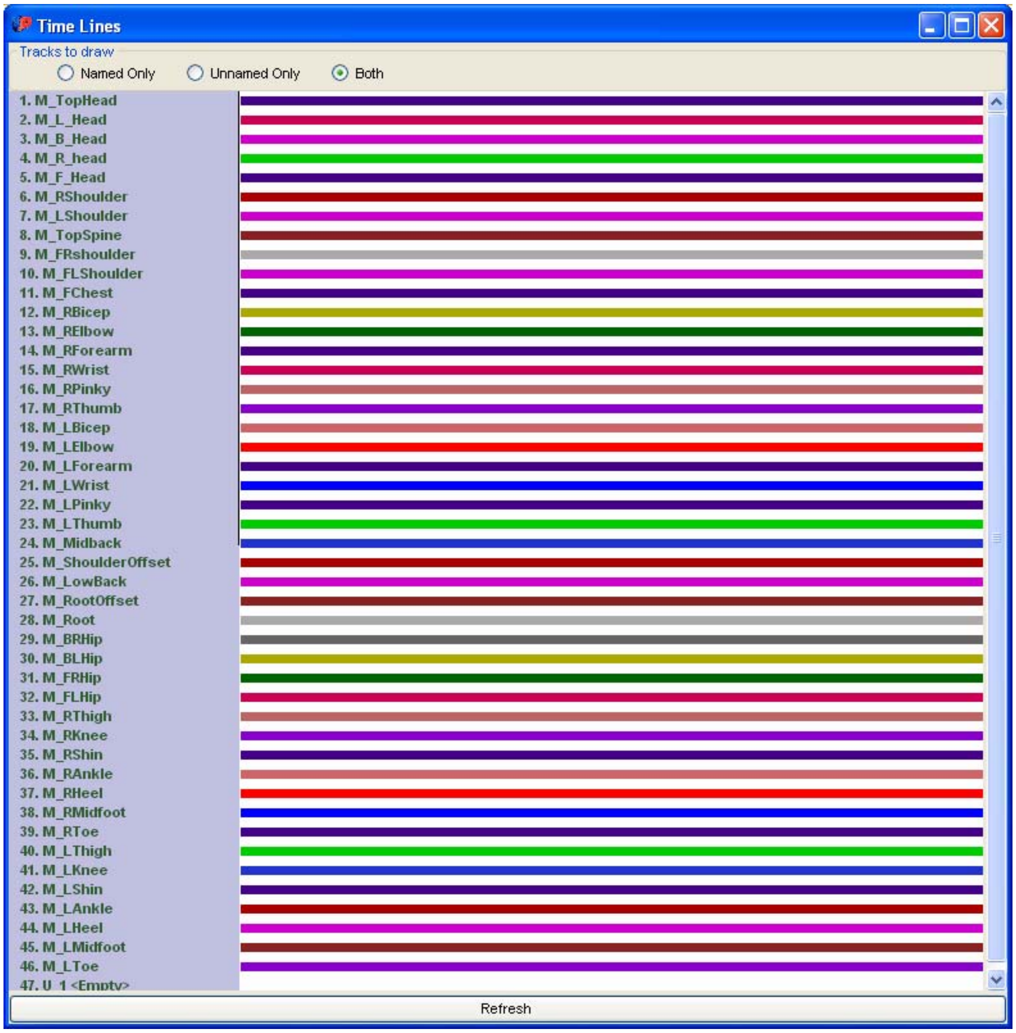
Figure 8-19. Data Painting



Time Lines

In the Menu Bar, select **Tools > Time Lines**. Time Lines provide a general overview of the quality of the data in the marker slots, showing any breaks in the stream of data for all markers.

Figure 8-20. Time Lines



Tracks to draw

○ Named Only ○ Unnamed Only ● Both

1. M_TopHead
2. M_L_Head
3. M_B_Head
4. M_R_head
5. M_F_Head
6. M_RShoulder
7. M_LShoulder
8. M_TopSpine
9. M_FRshoulder
10. M_FLShoulder
11. M_FChest
12. M_RBicep
13. M_RElbow
14. M_RForearm
15. M_RWrist
16. M_RPinky
17. M_RThumb
18. M_LBicep
19. M_LElbow
20. M_LForearm
21. M_LWrist
22. M_LPinky
23. M_LThumb
24. M_Midback
25. M_ShoulderOffset
26. M_LowBack
27. M_RootOffset
28. M_Root
29. M_BRHip
30. M_BLHip
31. M_FRHip
32. M_FLHip
33. M_RThigh
34. M_RKnee
35. M_RShin
36. M_RAnkle
37. M_RHeel
38. M_RMidfoot
39. M_RToe
40. M_LThigh
41. M_LKnee
42. M_LShin
43. M_LAnkle
44. M_LHeel
45. M_LMidfoot
46. M_LToe
47. U_1 <Empty>

Analysis Graphs

The Analysis graphs and their related control panel provide tools to analyze your realtime and post process data. This window has three tabs which calculate data for the following:

- Position, velocity, and acceleration
- Distance between markers
- Included angles

The Analysis graphs are activated by pressing the **F7** key.

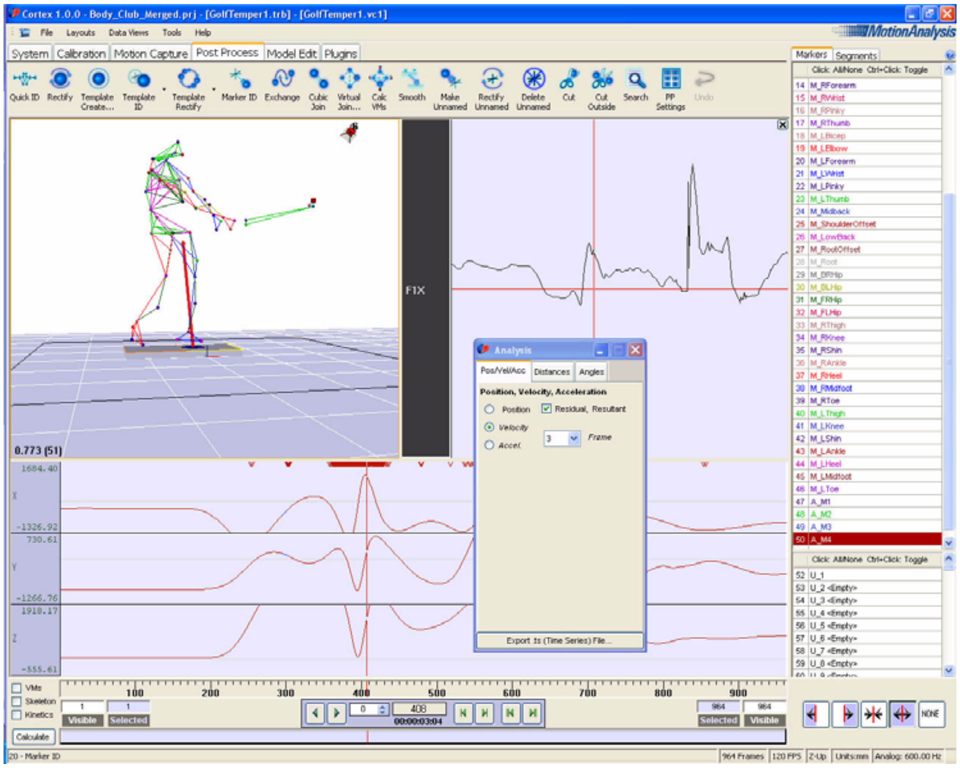
Position, Velocity, and Acceleration Tab

This tab creates graphs of the position data, calculated velocity data, or calculated acceleration data for up to 10 selected markers.

Note: Any number of marker data can be exported.

The number of frames used to calculate the velocity and acceleration data is set by the user. The number of frames used can be either 3, 5, 7, or 9. Using the higher number of frames to calculate the data will result in smoother output through noise reduction.

Figure 8-21. Position, Velocity, and Acceleration Tab



Position, Velocity, Acceleration

○ Position ☑ Residual, Resultant

● Velocity

○ Accel. 3 Frame

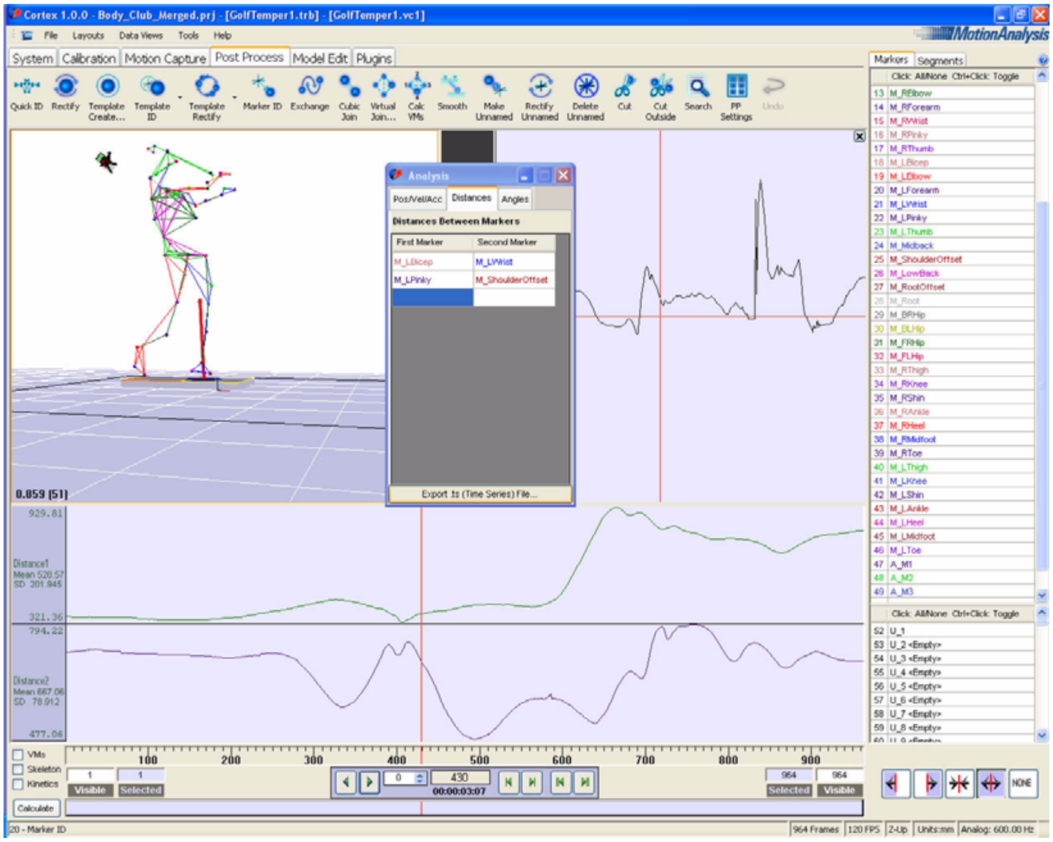
Analysis
Pos/Vel/Acc
Distances
Angles
Export .ts (Time Series) File...
System
Calibration
Motion Capture
Post Process
Model Edit
Plugins
F1X
Markers
Segments

Distance Between Two Markers Tab

The Distance Between Markers tab shows the distance between two selected markers for each frame throughout the tracked data. You may select any two markers in the tracked data to be analyzed by clicking those markers in the 3D View or on the marker list grids.

To delete a pair of markers from the grid, click on the row and press the **Delete** key. You may select and delete several rows at once by pressing **shift + click** on the rows and pressing **Delete**.

Figure 8-22. Distance Between Two Markers Tab


Cortex 1.0.0 - Body_Club_Merged.prj - [GolfTemper1.trb] - [GolfTemper1.vc1]
File
Layouts
Data Views
Tools
Help
MotionAnalysis
System
Calibration
Motion Capture
Post Process
Model Edit
Plugins
Quick ID
Rectify
Template Create...
Template ID
Template Rectify
Marker ID
Exchange
Cubic Join
Virtual Join...
Calc VMs
Smooth
Make Unnamed
Rectify Unnamed
Delete Unnamed
Cut
Cut Outside
Search
PP Settings
Undo
Analysis
Pos/Vel/Acc
Distances
Angles
Export .ts (Time Series) File...
0.859 [51]
929.81
Distance1
Mean 528.57
SD 201.945
321.36
794.22
Distance2
Mean 667.06
SD 78.912
477.06
VMs
Skeleton
Kinetics
Calculate
100
200
300
400
500
600
700
800
900
Visible
Selected
00:00:03:07
NONE
Markers
Segments
Click: All/None Ctrl+Click: Toggle
20 - Marker ID
964 Frames
120 FPS
2-Up
Units:mm
Analog: 600.00 Hz

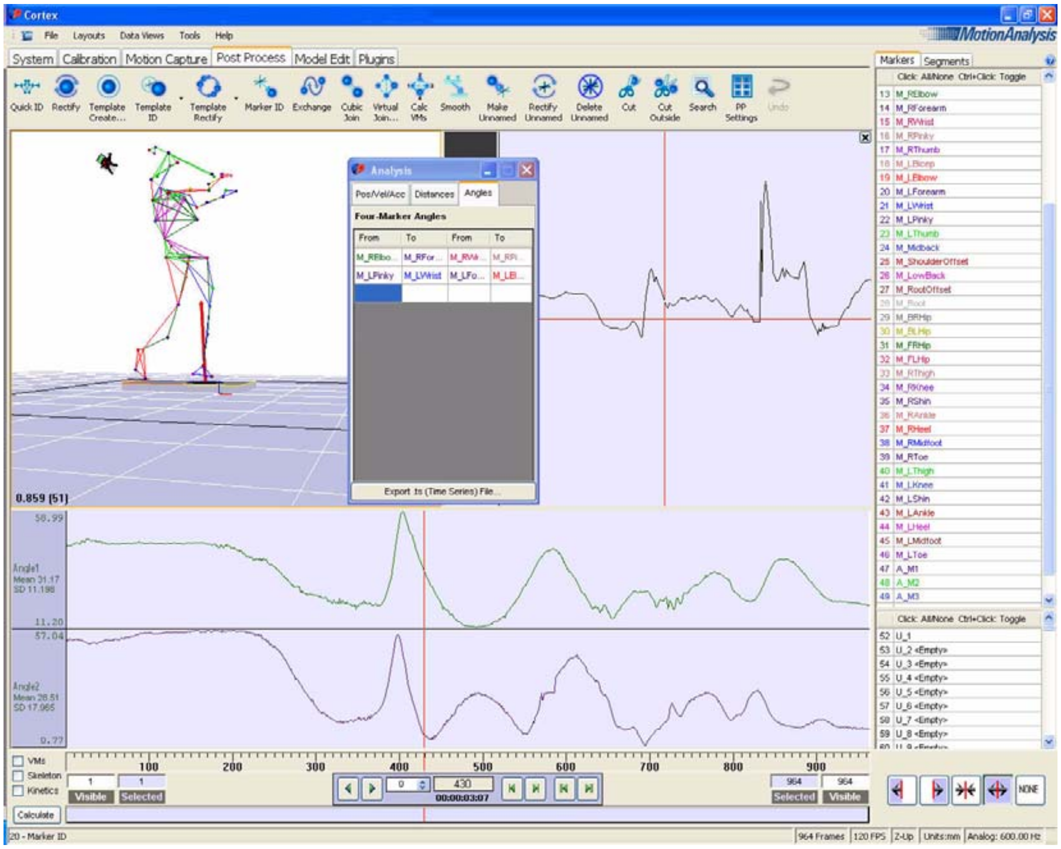
Distances Between Markers

First Marker	Second Marker
M_LBicep	M_LWrist
M_LPinky	M_ShoulderOffset

Included Angles Tab

The Included Angles tab allows you to select groups of four markers, which define two separate lines in space. Between these two lines, the angle is calculated for each frame through the tracked data. This information proves useful for detecting irregularities in movement, such as between two parts of a body. To delete a row, simply click on that row and press **Delete**. You may select and delete several rows at once by pressing **shift + click** on the rows and pressing **Delete**.

Figure 8-23. Included Angles Tab


Cortex
File
Layouts
Data Views
Tools
Help
MotionAnalysis
System
Calibration
Motion Capture
Post Process
Model Edit
Plugins
Quick ID
Rectify
Template Create...
Template ID
Template Rectify
Marker ID
Exchange
Cubic Join
Virtual Join...
Calc VMs
Smooth
Make Unnamed
Rectify Unnamed
Delete Unnamed
Cut
Cut Outside
Search
PP Settings
Undo
Analysis
Pos/Vel/Acc
Distances
Angles
Four-Marker Angles
Export .ts (Time Series) File...
Markers
Segments
Click: All/None Ctrl+Click: Toggle
0.859 (51)
Angle1
Mean 31.17
SD 11.198
Angle2
Mean 28.51
SD 17.965
VMs
Skeleton
Kinetics
Calculate
Visible
Selected
20 - Marker ID
964 Frames
120 FPS
Z-Up
Units:mm
Analog: 600.00 Hz

From	To	From	To
M_RElbo...	M_RFor...	M_RWr...	M_RPi...
M_LPinky	M_LWrist	M_LFo...	M_LB...

Exporting Analysis (Time Series) Information

To export an ASCII text viewable file, select the **Export.ts (Time Series) File...** button. This will write a file with the same file name as the tracked file you are working on. It will contain the information from all three Analysis tabs.

Post Processing Strategies and Tips

The steps necessary to clean up data will vary significantly from one user to another. These tips are guidelines that outline a general approach to successful editing sessions.

- It is best to start identifying from Frame 1 forward. Then, identify from the last frame backwards. This entails naming unnamed markers using the Marker ID and Quick ID tools.
- Use of Rectify over small frame ranges may help in cleaning the data by taking unnamed data into named tracks.
- After identifying, the Post Process tools can be used to fill gaps and cut out unwanted data sections, fix abnormalities, and smooth anomalies, and can be used to exchange switched markers.

Note: It is recommended to save your files often, especially when performing heavy edits.

- Many users will select all markers and all frames and execute a Join Linear or Join Cubic, and possibly a Smooth as a very last editing step.
- Learning and using Hot Keys is critical to high productivity.

Chapter 9 Model Edit Tab

Topic	Page
Overview	9-1
Markers Panel	9-2
Tree View Panel	9-4

Overview

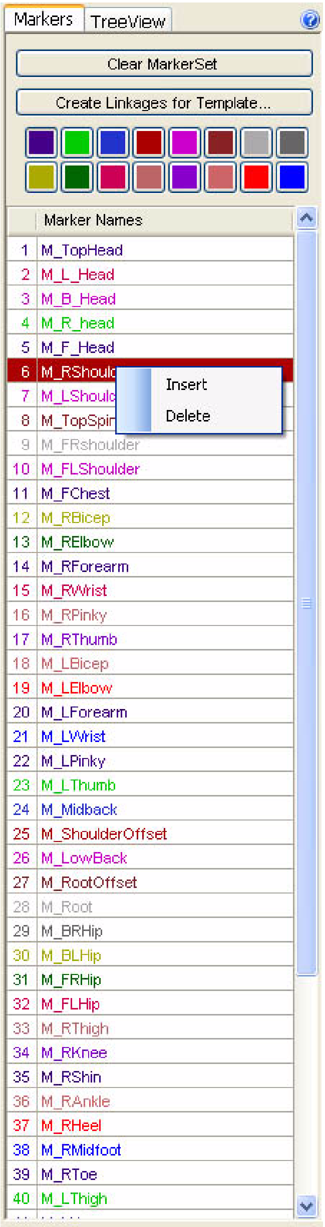
The Model Edit tab provides tools to build and modify the model parameters that are mandatory for the MarkerSet file. These parameters include markers names and colors, virtual markers, linkages between markers, skeleton types and segment names.

Note: It is important to save your MarkerSet after building the model by selecting **File > Save MarkerSet or Save MarkerSet As...** if you want to give it a new name. MarkerSets can also be selected moved between the Local folder and the System folder in the **Motion Capture > Objects** panel.

Markers Panel

The Markers panel is intended for building and modifying marker sets.

Figure 9-1. Markers Panel


Markers
TreeView
Clear MarkerSet
Create Linkages for Template...
Insert
Delete

	Marker Names
1	M_TopHead
2	M_L_Head
3	M_B_Head
4	M_R_head
5	M_F_Head
6	M_RShoulc
7	M_LShoulc
8	M_TopSpir
9	M_FRshoulder
10	M_FLShoulder
11	M_FChest
12	M_RBicep
13	M_RElbow
14	M_RForearm
15	M_RWrist
16	M_RPinky
17	M_RThumb
18	M_LBicep
19	M_LElbow
20	M_LForearm
21	M_LWrist
22	M_LPinky
23	M_LThumb
24	M_Midback
25	M_ShoulderOffset
26	M_LowBack
27	M_RootOffset
28	M_Root
29	M_BRHip
30	M_BLHip
31	M_FRHip
32	M_FLHip
33	M_RThigh
34	M_RKnee
35	M_RShin
36	M_RAnkle
37	M_RHeel
38	M_RMidfoot
39	M_RToe
40	M_LThigh

Clear MarkerSet Button

This button clears out the capture's marker set linkages and skeleton definitions

Create Linkages for Template Button

This button must be clicked prior to creating linkages on the 3D View. Linkages can be built by connecting the dots. Linkages should reflect the rigid or semi-rigid lines to aid in the template identifying mechanism.

Marker Names

Marker names are accepted in the markers grid when you press **Enter** on the keyboard.

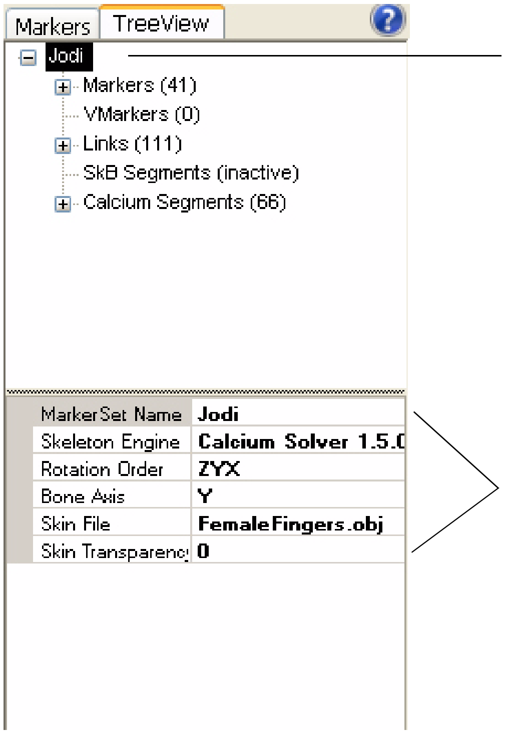
Marker Color Selector

Allows the user to select a specific color for any marker. Select the marker from the list and simply click on the color of preference.

Tree View Panel

The Tree View panel provides an overview of the primary elements (markers, linkages, virtual markers, and segments) of the model and allows you to reorder the markers in the marker set by dragging and dropping. You can also insert and delete markers as well.

Figure 9-2. Tree View Panel



Jodi
- Markers (41)
- VMarkers (0)
- Links (111)
- SkB Segments (inactive)
- Calcium Segments (66)

MarkerSet Name	Jodi
Skeleton Engine	Calcium Solver 1.5.
Rotation Order	ZYX
Bone Axis	Y
Skin File	FemaleFingers.obj
Skin Transparenc	0

MarkerSet Name

MarkerSet Properties

MarkerSet Properties

MarkerSet Properties > MarkerSet Name

The top line in the TreeView shows the important MarkerSet name (Jodi) which also shows up when you create a template for this person using this MarkerSet. It is a good idea to save the MarkerSet locally after creating or updating a template for this person.

MarkerSet Properties > Skeleton Engine

This provides a way to select which skeleton engine will be used to create the bone structure (if used). The choices are:

None

Turns off any skeleton calculations for the Motion Capture and Post Processing panels.

Skeleton Builder (SkB)

Turns on the skeleton builder definitions (if present in the capture file) and allows the skeleton to be calculated. To see the skeleton in the Motion Capture or Post Processing panels, you must have the Show Skeleton feature turned on in the 3D view (right-click in the 3D view and select). All **Cortex** users can calculate the **SkB** or **Calcium** skeletons after they have been defined, but creating and editing skeletons requires a separate software license.

Calcium Type Skeleton

Checking this option tells the software to use the Calcium Solver type skeleton. You must have the Show Skeleton feature turned on in the 3D window and you must have clicked the Calculate Skeleton button (with check box) in Post Processing to have the skeleton calculated. Model files created and edited in the **Si 2.0/Calcium** software can be imported from the **File > Skeleton Definitions > Import Skeleton (.mod) file...** menu item. Any user can run and calculate the Calcium Solver skeletons, but it takes a separate license to edit and create the MarkerSet files. The skeleton can be calculated in the Motion Capture panel from either live camera data or in the simulated realtime mode when you "Disconnect -Use Raw Files".

Note that this can have an optional MOD file associated to it.

SIMM OrthoTrak Skeleton

This skeleton calculation uses the Calcium Solver type skeleton and requires that you use the anatomically named marker set defined in the **SIMM** and **OrthoTrak** software. The **OrthoTrak SIMM** basic marker set uses fixed names like L.Shoulder, L.Wrist, and L.Knee for prominent marker locations. There are several required markers and many more optional markers. If you use this marker set, you do not need to use the **Si/ Calcium** software for creating a model (.mod) file. You must also use an additional "Static" trial with inside (medial) knee and ankle markers. You load the Static capture file, load the Static Trial, click this **SIMM OrthoTrak** button and then the **Calculate Skeleton** button. Then load the Walking (motion) trial and click the **Big Bone** button on the Post Processing screen. The Calcium Solver skeleton is calculated. To see the skeleton in the 3D window, select **Show Skeleton**. The skeleton can be calculated in the Motion Capture panel from either live camera data or in the simulated realtime mode when you "Disconnect - Use Raw Files".

Note that this requires an associated JNT file and an Init or Static trial.

MarkerSet Properties > Rotation Order

This specifies the default Euler angle rotation order for the child-parent angles defined for the Skeleton. The default is ZYX for historic reasons.

MarkerSet Properties > Bone Axis

This specifies which local coordinate system axis will be used for the bone.

MarkerSet Properties > Skin File

Skin files are flexible-mesh skins that can stretch across joints and different sized subjects.

The Skin File function allows you to select the two types of skins that work with **Cortex**.

- Collada (.dae) skins
- Legacy OBJ (.obj) skins

These skins that are defined for two different skeleton types and are located in the **User Files\Skins** directory.

If you are looking to develop an entirely new skin file, you will need to contact Motion Analysis Customer Support (support@motionanalysis.com) for information.

Skin Transparency

This sets the transparency attribute of the skin—100% means the skin is invisible, 0% is solid.

OrthoTrak Example with OBJ Skin

This shows one of the Samples files installed from the full Cortex setup file. If you do not have this, you can download the Samples from the Motion Analysis FTP site. Contact support@motionanalysis.com for details.

1. In **Cortex**, use the **Browse...** button in the upper right corner to: **C:\Program Files\Motion Analysis\Cortex2\Samples\SIMM - OrthoTrak Helen Hayes MarkerSet**
2. Select **File > Load Capture: Walk1.cap**.

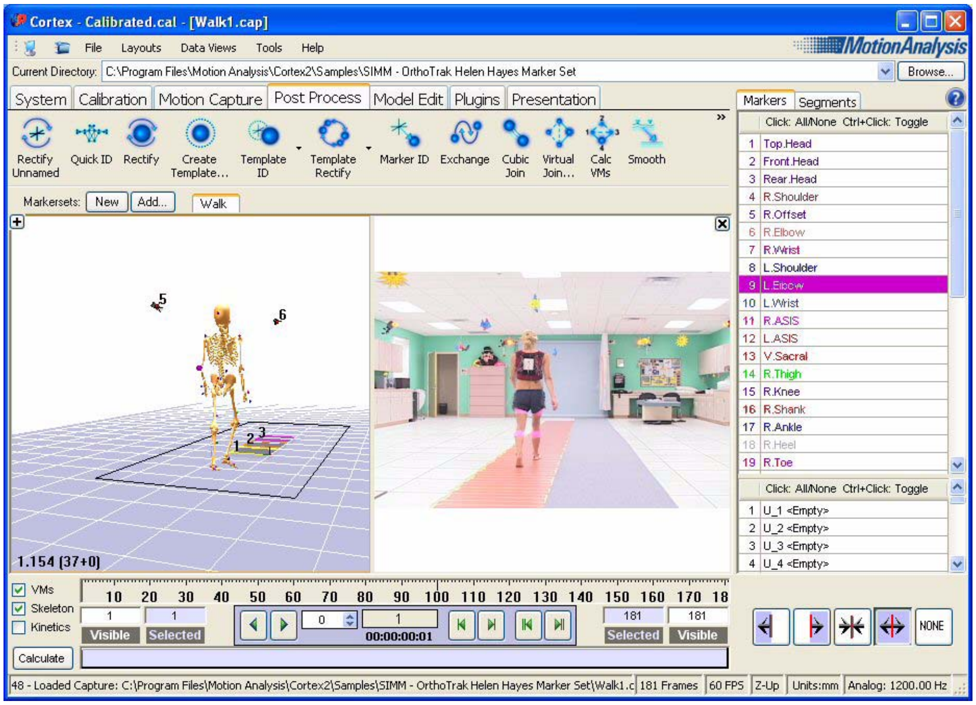
   Layouts: 2 Panes Left/Right Left Pane: 3D View (F3), Right Pane: Reference Video (F1)

3. Play You will see the stick figures and the reference video images.
4. To see the Skeleton (blue segments), and the PolyBones Skin, right click in the 3D View and check both **Skeleton** and **Skin**.

To see these calculated and displayed in simulated real time:

1. Select **File > Load Capture (Live): Walk1.cap**. This puts the software into the "Live" motion capture mode and selects the Walk1 capture file.
2. Click **Play**. What you see depends on which boxes you have checked in the lower left part of the "Real Time Dashboard". Check Tracking and Identifying to see the stick figure when you press Run. Check Skeleton to see the skeleton (blue segments) and the Skin (the brown Polybones that look like the bones in a human skeleton).This procedure will produce a subject with a skeleton and skin as shown in Figure 9-3.

Figure 9-3. OrthoTrak Skeleton and OBJ Skin Subject


Cortex - Calibrated.cal - [Walk1.cap]
File
Layouts
Data Views
Tools
Help
MotionAnalysis
Browse...
System
Calibration
Motion Capture
Post Process
Model Edit
Plugins
Presentation
Rectify Unnamed
Quick ID
Rectify
Create Template...
Template ID
Template Rectify
Marker ID
Exchange
Cubic Join
Virtual Join...
Calc VMs
Smooth
Markersets:
New
Add...
Walk
Markers
Segments
Click: All/None Ctrl+Click: Toggle
5
6
1
2
3
1.154 (37+0)
☑ VMs
☑ Skeleton
☐ Kinetics
10 20 30 40 50 60 70 80 90 100 110 120 130 140 150 160 170 18
1
1
Visible
Selected
0
1
00:00:00:01
181
181
Selected
Visible
NONE
Calculate

Current Directory: C:\Program Files\Motion Analysis\Cortex2\Samples\SIMM - OrthoTrak Helen Hayes Marker Set

	Click: All/None Ctrl+Click: Toggle
1	Top.Head
2	Front.Head
3	Rear.Head
4	R.Shoulder
5	R.Offset
6	R.Elbow
7	R.Wrist
8	L.Shoulder
9	L.Elbow
10	L.Wrist
11	R.ASIS
12	L.ASIS
13	V.Sacral
14	R.Thigh
15	R.Knee
16	R.Shank
17	R.Ankle
18	R.Heel
19	R.Toe

	Click: All/None Ctrl+Click: Toggle
1	U_1 <Empty>
2	U_2 <Empty>
3	U_3 <Empty>
4	U_4 <Empty>

48 - Loaded Capture: C:\Program Files\Motion Analysis\Cortex2\Samples\SIMM - OrthoTrak Helen Hayes Marker Set\Walk1.c | 181 Frames | 60 FPS | Z-Up | Units:mm | Analog: 1200.00 Hz

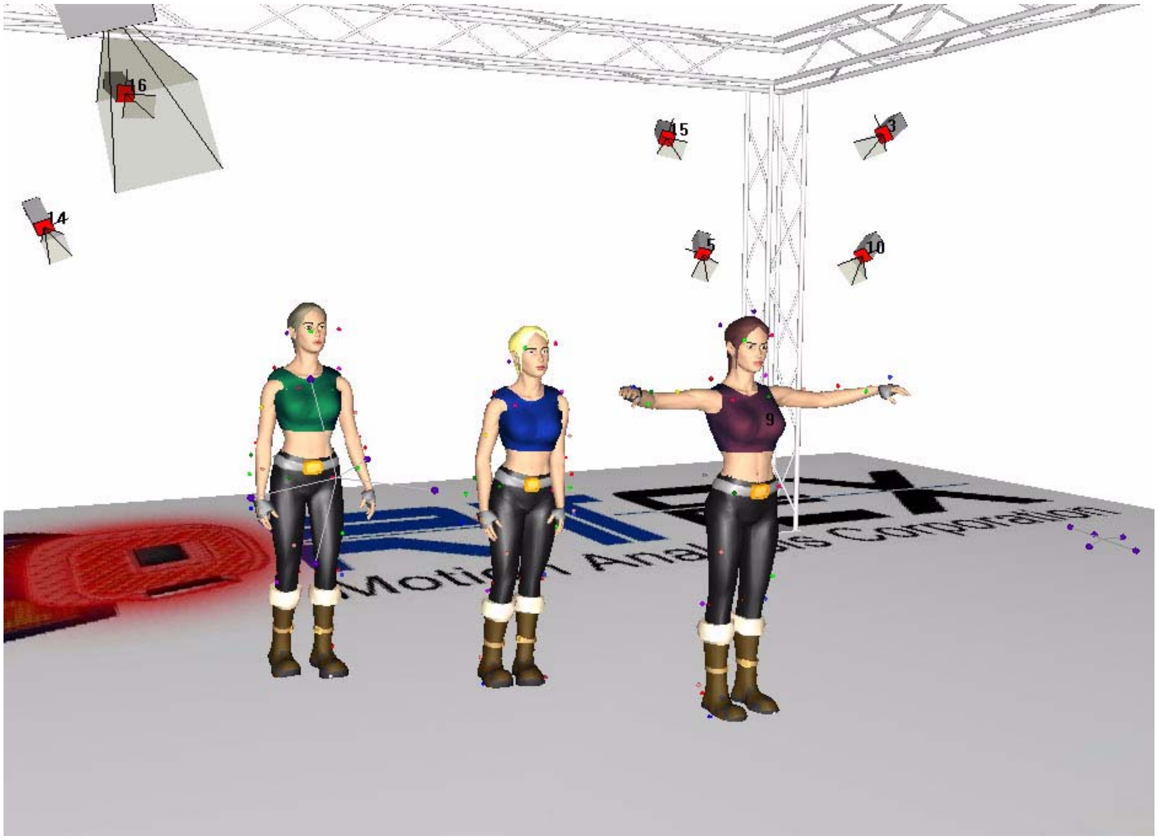
Collada Skin and Scene Example

The following example will show both the Collada skin and the scene.

1. In **Cortex**, Use the Browse... button in the upper right corner to open the **C:\Program Files\Motion Analysis\Cortex2\Samples\Three Person Collada Dance\Triplets_1.cap** file**.**
2. Right-click in the 3D Display and select **Unshow Linkages, Show Skin**, **Show Scene.**
3. Click **Play...** Press the 9 Hot key for the "Graphics Only" view toggle without the menu items.

This procedure will produce a subject with a skeleton and skin as shown in Figure 9-4.

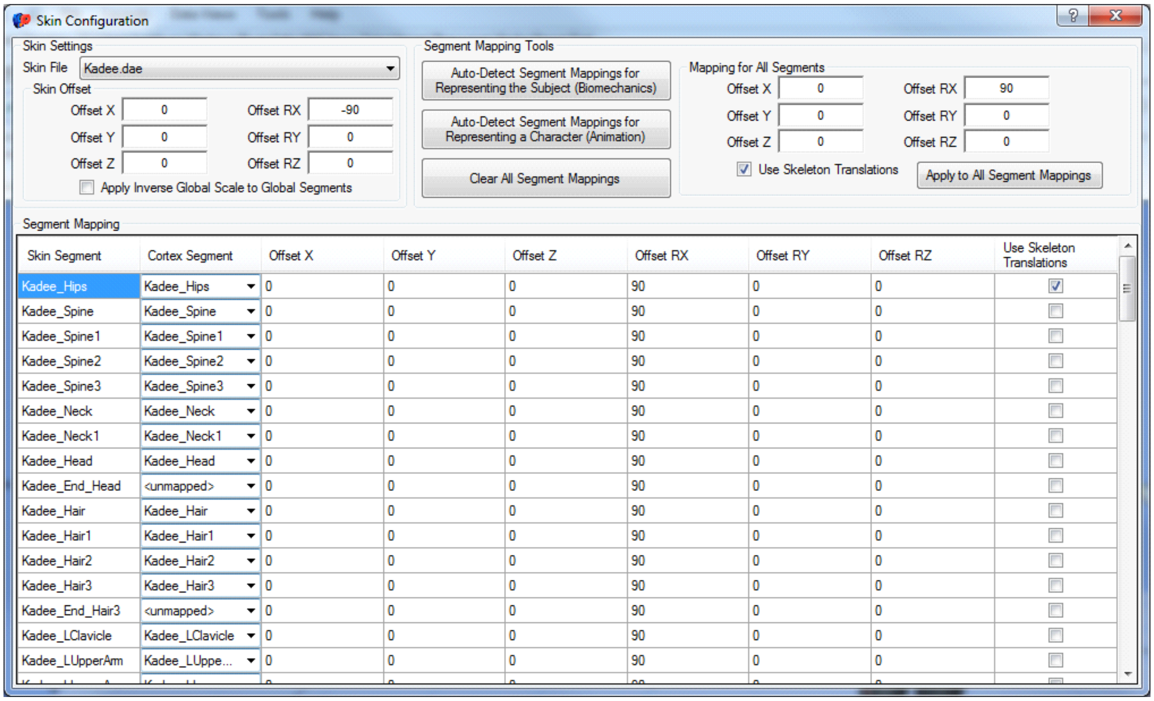
Figure 9-4. Collada Skin and Collada Scene



Collada Skin Configuration Pop-Up

Cortex now supports the ability for skins to be imported from Collada (.dae) files. The Collada file format contains a lot of information. For the purposes of skinning, the main components are a mesh, a skeleton, and a relationship between the two. This document refers to these three things as: the *Collada mesh*, the *Collada skeleton*, and the *Collada bind pose*. In order to use a skin in Cortex, a way of driving the Collada skeleton must be defined. This is done by using the Skin Configuration Popup to define a mapping between the MarkerSet's skeleton and the Collada Skeleton.

Figure 9-5. Skin Configuration Popup


Skin Configuration
Segment Mapping Tools
Auto-Detect Segment Mappings for Representing the Subject (Biomechanics)
Auto-Detect Segment Mappings for Representing a Character (Animation)
Clear All Segment Mappings
Apply to All Segment Mappings

Skin Settings

Skin File: Kadee.dae

Skin Offset

Offset X: 0
Offset Y: 0
Offset Z: 0
Offset RX: -90
Offset RY: 0
Offset RZ: 0
☐ Apply Inverse Global Scale to Global Segments

Mapping for All Segments

Offset X: 0
Offset Y: 0
Offset Z: 0
Offset RX: 90
Offset RY: 0
Offset RZ: 0
☑ Use Skeleton Translations

Segment Mapping

Skin Segment	Cortex Segment	Offset X	Offset Y	Offset Z	Offset RX	Offset RY	Offset RZ	Use Skeleton Translations
Kadee_Hips	Kadee_Hips	0	0	0	90	0	0	☑
Kadee_Spine	Kadee_Spine	0	0	0	90	0	0	☐
Kadee_Spine1	Kadee_Spine1	0	0	0	90	0	0	☐
Kadee_Spine2	Kadee_Spine2	0	0	0	90	0	0	☐
Kadee_Spine3	Kadee_Spine3	0	0	0	90	0	0	☐
Kadee_Neck	Kadee_Neck	0	0	0	90	0	0	☐
Kadee_Neck1	Kadee_Neck1	0	0	0	90	0	0	☐
Kadee_Head	Kadee_Head	0	0	0	90	0	0	☐
Kadee_End_Head	<unmapped>	0	0	0	90	0	0	☐
Kadee_Hair	Kadee_Hair	0	0	0	90	0	0	☐
Kadee_Hair1	Kadee_Hair1	0	0	0	90	0	0	☐
Kadee_Hair2	Kadee_Hair2	0	0	0	90	0	0	☐
Kadee_Hair3	Kadee_Hair3	0	0	0	90	0	0	☐
Kadee_End_Hair3	<unmapped>	0	0	0	90	0	0	☐
Kadee_LClavicle	Kadee_LClavicle	0	0	0	90	0	0	☐
Kadee_LUpperArm	Kadee_LUppe...	0	0	0	90	0	0	☐

Skin Settings

The Skins Settings area is in the top left of the Skin Configuration Dialog. These settings are where skin-wide settings are located.

Skin File

This drop down is used to select a skin from the files in the UserFiles\Skins folder.

Skin Offset

The global coordinate system that defines the Collada mesh and the calibration coordinates of Cortex do not always match. These offsets are used to align the two coordinate systems. Different up-axis' is one example of why this would be used.

Apply Inverse Global Scale to Global Segments

If the skin is being displayed in the scale defined in the Collada file (see **Segment Mapping > Use Skeleton Translations** below), then this box should be checked so that the skin's global position is consistent with the scale that it is being rendered at. If this is not the case, as skin that is shorter than the actor would have feet that do not touch the floor.

Segment Mapping

The Segment Mapping table displays and allows editing of all the Collada segment mappings, segment mapping for short. A segment mapping consists of eight parts:

Cortex Segment

This setting defines which segment in the MarkerSet skeleton drives the Collada segment. This can also be set to <unmapped>, in which case the segment maintains its relative position to its parent as defined in the Collada bind pose.

Offset X, Offset Y, Offset Z, Offset RX, Offset RY, Offset RZ

These settings describe a transformation from the Collada segment's local coordinate system to the local coordinate system of the MarkerSet segment. The angles are degrees, applied in ZYX order. This is used, for example, if the bone axis of the Collada skeleton doesn't match the bone axis of the MarkerSet skeleton.

Use Skeleton Translations

If this setting is enabled, the Collada segment has the translation data from the MarkerSet segment applied to it. If this is not checked, only rotation data is applied. This box should always be set for any segments that have no parent, otherwise the portions of the skin rooted at this segment won't move around the volume. For parented segments, checking the box means that the skin will be displayed in the scale of the MarkerSet skeleton (probably what is desired for BioMechanics users). Unchecking it means that the skin will be displayed in the scale of the skin (probably what is desired for Animation users).

Segment Mapping Tools

The Segment Mapping Tools area provides tools for adjusting all segment mappings at once.

Auto-Detect Segment Mappings for Representing the Subject

This buttons attempts to prepare the skin for use in representing the mocap subject. More explanation of this scenario and why it would be used is provided below as a common use example. This is the most common use of skins for Biomechanics users. If a Collada segment name is contained within the name of a Cortex segment, then that Cortex segment is used to drive the Collada segment. The Use Skeleton Translations value of a mapping is set to true if and only if that segment does not have a parent (it is global). The rotational offsets are determined by assuming that the first child of a segment is along the bone axis of that segment. Then a transformation is calculated which aligns the Collada segment and Cortex segment bone axis'. Additionally, the skin setting for applying the inverse global scale factor is enabled.

Auto-Detect Segment Mappings for Representing a Character

This buttons attempts to prepare the skin for use in representing a rendered character. More explanation of this scenario and why it would be used is provided below as a common use example. This is the most common use of skins for Animation users. If a Collada segment name is contained within the name of a Cortex segment, then that Cortex segment is used to drive the Collada segment. The Use Skeleton Translations value of a mapping is set to true if and only if that segment does not have a parent (it is global). The rotational offsets are determined by assuming that the first child of a segment is along the bone axis of that segment. Then a transformation is calculated which aligns the Collada segment and Cortex segment bone axis'. Additionally, the skin setting for applying the inverse global scale factor is enabled.

Clear All Segment Mappings

This tool clears all of the Collada segment mappings.

Apply Mapping Offset to All Segments

This tool applies the mapping settings in the Mapping for All Segments area to all of the Collada segments.

Two Common Use Examples

When the Skin Represents the Mocap Actor (Biomechanics)

One case for using skins is to represent the person being tracked more accurately than using markers/links/segments. In this case the Collada segments should resize to the segment lengths solved for in **Cortex**. To achieve this affect, the segment mappings should all be configured either by manually or using the Auto-Detect Segment Mappings button. Once the correct segment correspondences and offsets have been configured, enable the Use Skeleton Translations option for each segment mapping. This setting causes the Collada segments to resize to the segment data being solved in Cortex, effectively stretching or compressing the skin to fit the tracking subject. In this case the Apply Inverse Global Scale to Global Segments option for the skin should be disabled.

When the Skin Represents an Animated Character (Animation)

One case for using skins is to represent a character, whose dimensions are not the same as the mocap actor. In this case the skin should use rotation data from the segments solved for in Cortex, but the segment lengths should remain the same as their definition in the Collada file. To achieve this affect, the segment mappings should all be configured either by manually or using the Auto-Detect Segment Mappings button. Once the correct segment correspondences and offsets have been configured, disable the Use Skeleton Translations for each non-global segment's mapping. This setting causes the Collada segments to retain their length, even though the solved data can differ. The global segments MUST have this box checked, however, or the character will not move about the volume. The result of this will be a skin which matches the dimensions of the character, as opposed to the actor. The skin will be rooted at the root of the actor, however, and the length of the extremities will likely differ. This can result in the character's feet not touching the ground. Enabling the Apply Inverse Global Scale to Global Segments skin option will cause the character's position to be scaled to match the scale of the skin. This adjustment will change the character's position in the X, Y, and Z dimensions, so the skin may no longer sit exactly on top of the skeleton data being displayed in Cortex.

Making a Collada Skin for a Cortex Calcium Model in Maya

To make a Collada skin for **Cortex** in Maya, you will need a Collada exporter for Maya.

If you have a Collada exporter installed you would:

In Maya

1. Load character for which you will be making a skin.
2. Export HTR using MacFileIO to create a basepose skeleton to be used in the Calcium setup.
3. Export .dae file from Maya using the Collada export plugin.
4. Place the .dae file in the **Cortex2\UserFiles\Skins** folder

In Cortex 2.1

1. Load .cap file to be used for character setup (usually an INIT or ROM capture).
2. Create a skeleton using the HTR basepose.
3. Setup the Calcium model.
4. Set the skin to a matching .dae model in the Calcium setup panel (bottom right when Calcium is selected and segments tab selected).

Tree View > Markers

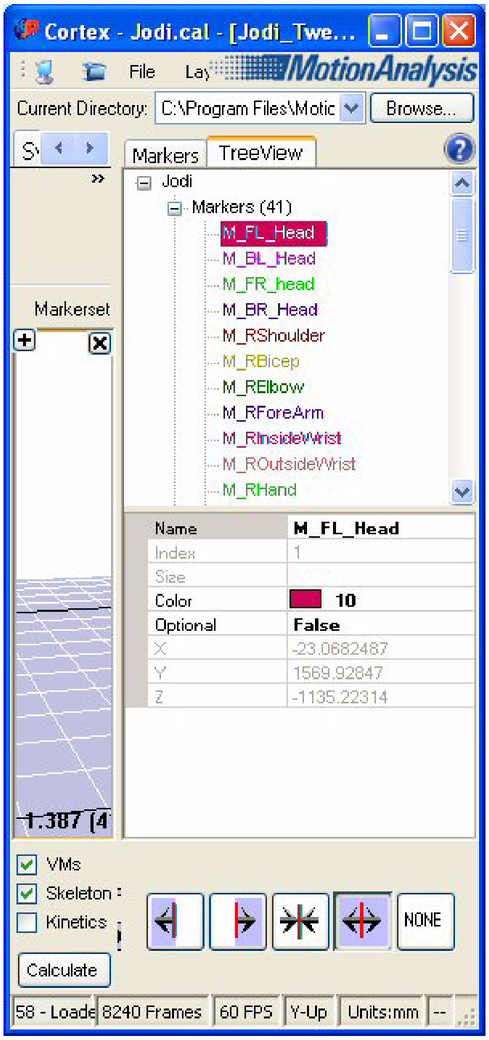
Selecting Markers in the Treeview allows you to make changes to any of the markers associated with the current capture file using the property value selections at the bottom of the panel. You can also insert, delete and select a range of markers.The marker values that can be changed include the following:

Name	Displays and edits the name of the selected marker.
Index	Displays the marker number, in the order the marker appears in the marker list. This is not editable.
Size	This is not used at this time.
Color	Displays and edits the color associated to the maker in the 3D View. To change the color, click on the color property and select from the drop-down menu.
Optional: False (default)	False means this marker is not Optional, it is REQUIRED to be present when identifying markers with the Template mechanism in real time and with Template Identify mechanism in Post Processing. In Cortex 1 and earlier software, all markers were REQUIRED to be present for the template to identify them in real time or in Template Identify in Post Processing.
Optional: True	This means this marker is NOT needed for the real time Template mechanism to work. Optional markers can be used for adding additional markers to a MarkerSet without interfering with the template identifying mechanism. It is expected that only a few of the Optional markers will be used.

X, Y, and Z Values

The 3D coordinates of the marker in calibration units at the frame number where the marker is selected. It is not updated with every frame change, but is updated when you select the marker.

Figure 9-6. Marker Parameters


Cortex - Jodi.cal - [Jodi_Twe...
File
Lay
MotionAnalysis
Current Directory:
C:\Program Files\Motic
Browse...
S\
Markers
TreeView
Jodi
Markers (41)
M_FL_Head
M_BL_Head
M_FR_head
M_BR_Head
M_RShoulder
M_RBicep
M_RElbow
M_RForeArm
M_RInsideWrist
M_ROutsideWrist
M_RHand
Markerset
1.387 (4
VMs
Skeleton
Kinetics
Calculate
NONE
58 - Loade
8240 Frames
60 FPS
Y-Up
Units:mm
--

Name	M_FL_Head
Index	1
Size	
Color	🟥 10
Optional	False
X	-23.0682487
Y	1569.92847
Z	-1135.22314

Tree View > VMarkers (Virtual Markers)

Virtual markers are markers that get their position from a combination of the position of two or three actual markers in the motion capture data. Typically, a virtual marker is used to generate the actual joint center position of the performer (or subject) being motion captured. This is necessary since the actual markers lie on the outside of the performer. Joint center markers are desirable for use with analytical and skeleton reconstruction tools.

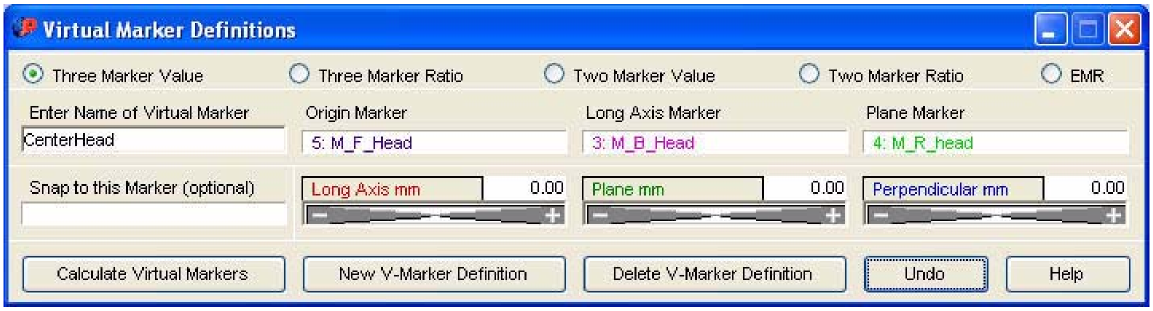
Virtual Marker Definitions

There are two methods for defining Virtual Markers (VM):

1. **2 Marker -** Two markers are used to define a line in space. A new virtual marker can be calculated anywhere on this line.
2. **3 Marker -** Three markers are used to define a plane in space. A new virtual marker can be calculated anywhere in space relative to the origin of this plane.

The placement of the virtual marker along a line or relative to a plane can be accomplished in real world measured values using the units of calibration as the units of measurement, or as a ratio. In the case of a line, the ratio is based on the distance between the two markers defining the line. In the case of the plane, the ratio is based on the distance between the two markers defining the Y axis of the plane.

Figure 9-7. Example Virtual Marker Setup


Virtual Marker Definitions
Calculate Virtual Markers
New V-Marker Definition
Delete V-Marker Definition
Undo
Help

● Three Marker Value ○ Three Marker Ratio ○ Two Marker Value ○ Two Marker Ratio ○ EMR

Enter Name of Virtual Marker: CenterHead
Origin Marker: 5: M_F_Head
Long Axis Marker: 3: M_B_Head
Plane Marker: 4: M_R_head
Snap to this Marker (optional):
Long Axis mm 0.00
Plane mm 0.00
Perpendicular mm 0.00

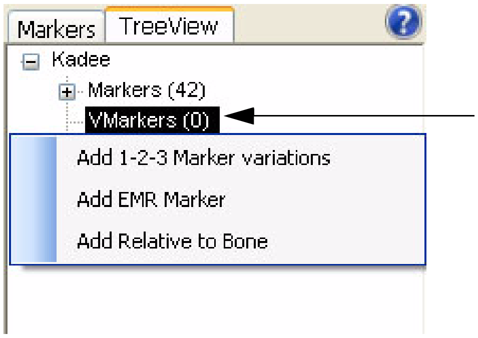
Degrees of Freedom

A segment's movement characteristics can be expressed as having various degrees-of-freedom. For example, if a single marker placed on the right shoulder is used to define the origin of the right upper arm, and we track this marker through space creating a trajectory, we will express the movement of the right upper arm origin as having 3 degrees-of-freedom (translations in X,Y, and Z).

If we add another marker to the right elbow and track it along with the marker on the right shoulder, we can now express movement of the right upper arm segment as having 5 degrees-of-freedom (translations in X, Y, and Z, and rotations in X and Z). This assumes that the Y axis extends from the right shoulder to the right elbow. If we add a third marker to the right wrist and track all three markers, we now have 6 degrees-of-freedom for the right upper arm segment.

VMarkers Right-Click Menu

Figure 9-8.


Markers
TreeView
Kadee
Markers (42)
VMarkers (0)
Add 1-2-3 Marker variations
Add EMR Marker
Add Relative to Bone

Right Click

Add 1-2-3 Marker Variations

This launches the Virtual Marker Definitions interface (refer to Figure 9-7 on page 9-15).

Add EMR Marker

This adds a virtual marker for use with the EMR (Eye Mark Recorder).

Add Relative to Bone

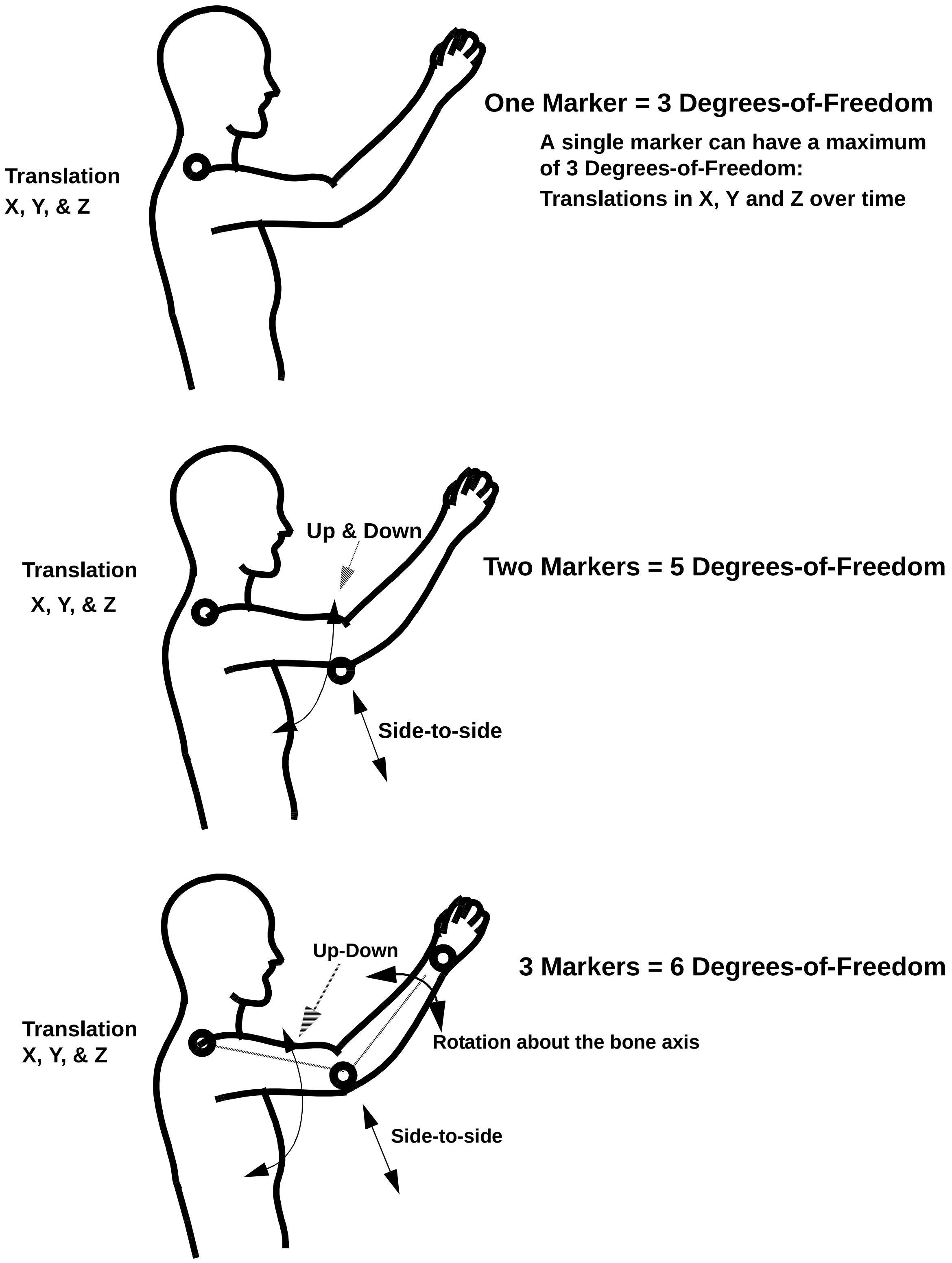
This adds a new virtual marker with the following properties:

- Name—Name of new virtual marker
- Index—Number in the list
- Type—Relative to the bone
- Marker—Original marker to be transformed
- Segment—Defines the new origin and coordinate system that the Calculate Virtual Marker button transforms the original marker to the new coordinate system

Note: Selecting Global as the segment give a status of “Empty”. There is no data for the transformed marker.

Note: The Type, Marker, and Segment properties can be changed with the drop-down menus.

Figure 9-9. Marker Number vs. Degrees of Freedom



One Marker = 3 Degrees-of-Freedom

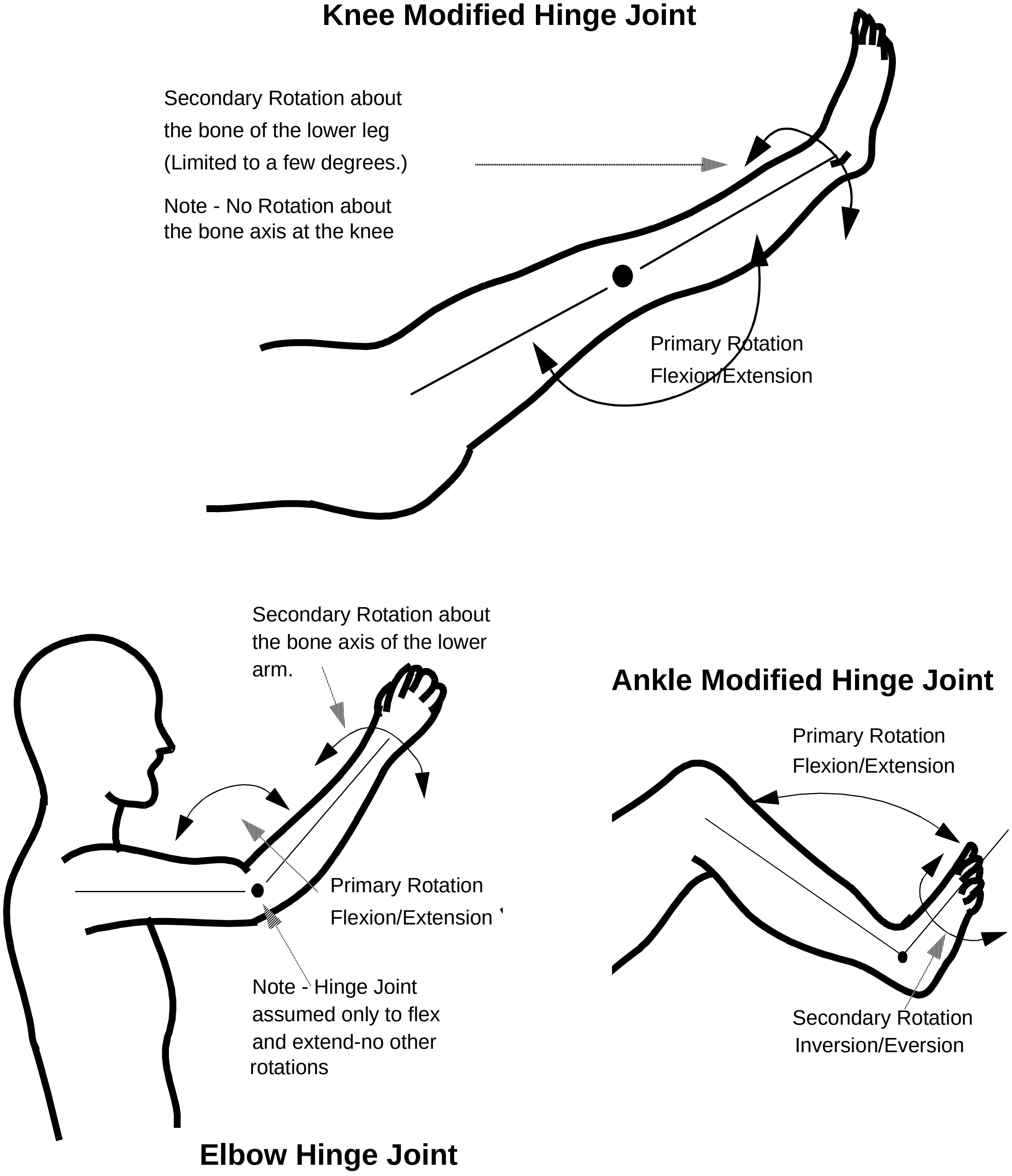
A single marker can have a maximum of 3 Degrees-of-Freedom: Translations in X, Y and Z over time

Two Markers = 5 Degrees-of-Freedom

3 Markers = 6 Degrees-of-Freedom

Translation
X, Y, & Z
Up & Down
Translation
X, Y, & Z
Side-to-side
Up-Down
Translation
X, Y, & Z
Rotation about the bone axis
Side-to-side

Figure 9-10. Examples of Hinge Joints


Knee Modified Hinge Joint
Secondary Rotation about the bone of the lower leg (Limited to a few degrees.)
Note - No Rotation about the bone axis at the knee
Primary Rotation Flexion/Extension
Secondary Rotation about the bone axis of the lower arm.
Primary Rotation Flexion/Extension
Note - Hinge Joint assumed only to flex and extend-no other rotations
Elbow Hinge Joint
Ankle Modified Hinge Joint
Primary Rotation Flexion/Extension
Secondary Rotation Inversion/Eversion

Calculating Virtual Marker Tracks

Calculate virtual marker trajectories based on the Virtual Marker definitions in the current MarkerSet. Virtual Markers are cleared when you track any new data.

Track and edit your trials before calculating the Virtual Marker Tracks.

1. Open the Virtual Markers Definitions form by clicking the **V-Marker Definitions** button in Model Edit or by selecting **Tools > Virtual Marker Definitions** in the Menu Bar.
2. Fill out the Virtual Marker Definitions form for the desired markers.
3. Click **Calculate** to calculate the virtual marker positions.

Virtual Marker Notes and Examples

For notes and examples on how to use Virtual Markers, there are two valuable sources:

1. Video tutorials from the Cortex **Help > Tutorials** menu.

   The first of this set of three tutorials shows how to set up and use Virtual Markers. To see this, you will need to install the full Samples and Tutorials from the **Cortex** installation CD or FTP site.

2. KinTools RT User's Manual

Tree View > Links

Selecting any of the links in the Treeview allows you to make changes to the links in the current capture file. The link property values that can be changed include the following: Right-click can only delete.

Index

Displays the link number, in the order the link appears in the list of links for the capture. This is not editable.

Marker1

Allows you to select and edit which marker is the first end point of the link definition. To edit, click on the property and select from the drop-down menu.

Marker2

Allows you to select and edit which marker is the 2nd (of two) end point of the link definition. To edit, click on the property and select from the drop-down menu.

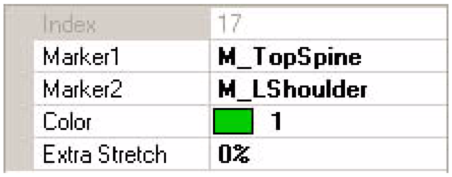
Color

Displays and edits the color associated to the link in the 3D View. To change the color, click on the color property and select from the drop-down menu.

Extra Stretch

The Extra Stretch factor is the amount (in percent, refer to Figure 9-11) that a link is allowed to stretch beyond the measured template. The template is usually measured from a Range of Motion capture and that motion is not always an adequate representation. Data captures often push the body closes to its limits. The Extra Stretch gives an appropriate margin to allow real captures to go beyond the template.

Figure 9-11. Link Property Values



Index	17
Marker1	**M_TopSpine**
Marker2	**M_LShoulder**
Color	🟩 **1**
Extra Stretch	**0%**

What confuses the user most is that rigid body parts (the head is a good example) will not have their markers move around much no matter what data you use to create the template. So almost any template will work to give you values with high confidence. Conversely, if you have links that are stretchy, it's easy to not get a good template for it and so your confidence in the template will be less.

Because of this, many users think that the Extra Stretch factor is a statement about the elasticity of the link, which it isn't. A link could be put between a hand marker and the toe marker but as long as it had sufficient data for the template Extra Stretch could be set to 1 (the lowest) and have it work just fine.

Multiple Link Selection—Multiple links can be selected by pressing the **Ctrl + Shift** buttons on the keyboard and clicking on the individual links with the mouse. Color and Extra Stretch properties can be edited for setting groups of links together.

This is why there is a **CreateTemplate.sky** script. It shows how to use multiple TRB files as input to the template creation (and extension) process.

Assuming a standard Range of Motion (ROM) file, the Extra Stretch values are normally set as follows:

- 10 for the head
- 15 for the links on the hips/pelvis
- 15 for the feet
- 20 everywhere else

15 is the default value for new links.

This is a starting point. As data is tracked, you can fine-tune the Extra Stretch values. Smaller values that work consistently will result in fast identifying and fewer errors.

Create Template: Show Template Linkages

An effective tool in changing the settings and organizing the linkages can be found in the **Create Template > Show Template Linkages** check box under the Post Process Tool Strip. For more information, refer to "Template Create..." on page 8-12.

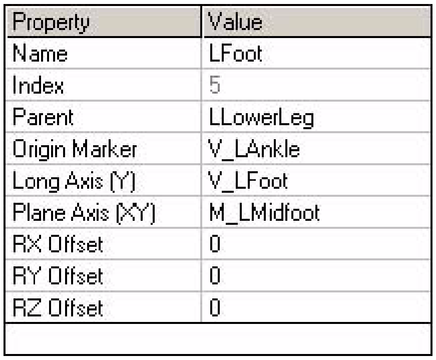
General Notes on Extra Stretch

- Extending the template works exactly as if you took all the TRB data used to create the template and put it end to end and did a Create Template with the whole works at once.
- If the ES factors are too large you get misidentified markers.
- If the ES factors are too small (and your template isn't complete enough) you will get unidentified markers.
- The template is a pair of Min/Max values for each link. These values only get farther apart as you extend the template. If this value becomes too great (as might happen if you had bad data to create the template), you must start the template creation process over from the beginning. There is no function to revalue the numbers, hence, this is why there is a Sky script for this. It makes it trivial to redo the template creation process.

Tree View > SkB Segments

Name	Displays and edits the name of the selected SkB segment.
Index	Displays the SkB segment number, in the order the segment appears in the list for the capture. This is not editable.
Parent	Displays the parent segment of the selected SkB segment. To edit, click on the property and select from the drop-down menu.
Origin Marker	Allows you to select and edit which marker is the Origin Marker of the SkB segment definition. To edit, click on the property and select from the drop-down menu.
Long Axis (Y)	Allows you to select and edit which marker is the Long Axis (Y) of the SkB segment definition. To edit, click on the property and select from the drop-down menu.
Plane Axis (XY)	Allows you to select and edit which marker is the Plane Axis (XY) of the SkB segment definition. To edit, click on the property and select from the drop-down menu.
RX Offset	RX is used to rotate the bone in the SkB segment along the X axis. RX is not used very often compared to RY. If you select a segment to rotate, it will bring up the rotation gizmo.
RY Offset	RY is used to rotate the bone along the Y axis. If you select a segment to rotate, it will bring up the rotation gizmo.
RZ Offset	RZ is used to rotate the bone in the SkB segment along the Z axis. RZ is not used very often compared to RY. If you select a segment to rotate, it will bring up the rotation gizmo.

Figure 9-12. Skeleton Builder Segments Property Values



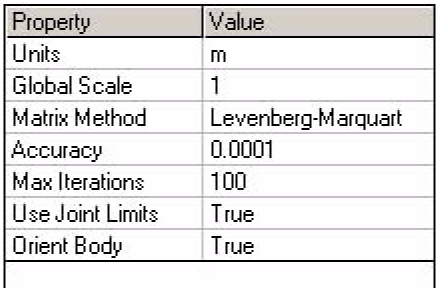
Property	Value
Name	LFoot
Index	5
Parent	LLowerLeg
Origin Marker	V_LAnkle
Long Axis (Y)	V_LFoot
Plane Axis (XY)	M_LMidfoot
RX Offset	0
RY Offset	0
RZ Offset	0

The various skeleton types are described in Chapter 13, Skeleton Types.

Tree View > Calcium Segments

Calcium is the graphical user interface to the Solver engine. Solver is the powerful numerical tool for calculating skeleton motion from marker data. The Calcium interface in **Cortex** is what allows you to correlate the positions of a marker pose to the initial pose of a skeleton. The skeleton is usually created in an outside animation package, such as Maya, 3D Studio Max or Kaydara and then exported to an HTR file by a Motion Analysis file IO plugin for that package. In this example we're using a skeleton from a Maya character.

Figure 9-13. Calcium Segments Property Values



Property	Value
Units	m
Global Scale	1
Matrix Method	Levenberg-Marquart
Accuracy	0.0001
Max Iterations	100
Use Joint Limits	True
Orient Body	True

Units

Units of the Calcium segment lengths. Select from the drop-down menu in meters, centimeters, and millimeters.

Global Scale

Changes the scale of the entire hierarchy, multiplied by the number set (e.g. a value of 10 would scale the hierarchy by 10 times the original size). This provides a quick method for scaling the HTR file to fit the marker cloud in the model pose.

Matrix Method

There are two matrix methods to choose from:

- **Gauss Newton**—Which is faster at solving, but not as robust. This is generally used in Real Time applications.
- **Levenberg-Marquart**—While is more robust, but not as fast. This should only be used in PP mode.

Accuracy

This is the accuracy parameter for the solve. It is generally set to 0.0001 and then left alone. It can be useful to debug and troubleshoot the Calcium segment.

Max Iterations

This is the number of iterations the solver goes through to solve. When the solver gets "stuck", it can potentially iterate forever. Usually the solve happens in a very small number of iterations (1-5). Setting it to 100 is more than enough.

Use Joint Limits

Enables or disables the use of joint limits in the Calcium model. Generally it is recommended to be turned off for animation applications. If the solution has joints flipping around, turn it off. Any model created from a joint file should have the limits enabled.

Orient Body

This is important on the first frame of any solve. First orient the root bone to the root bone markers, then do the solve. This helps to eliminate some first frame errors when bones get oriented incorrectly.

Note: There is still a bug where joints get turned around on the first frame. The solve changes randomly whenever these last two flags are changed. User beware.

It is recommended that Orient Body is set to False when Real Time operation performance is a factor.

For complete information on Calcium software and Calcium segment definitions, please reference the *Calcium for Cortex Quick-Start Guide* (p/n 651-1920-010).

Chapter 10

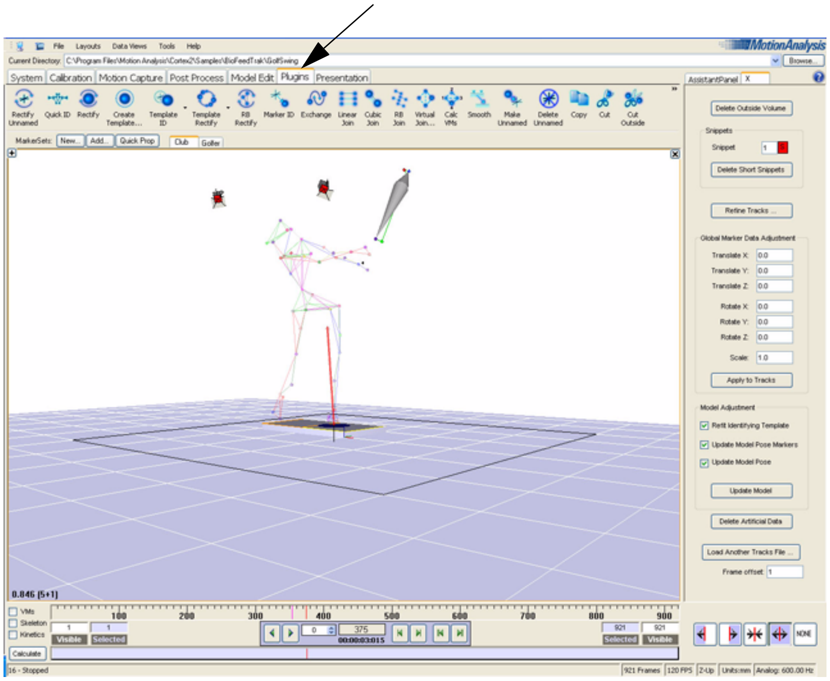
Plugins Tab

Topic	Page
Overview	10-1
X Panel	10-2
Assistant Panel	10-7

Overview

The Plugins tab houses the X panel. Other plugins can be added by copying the **pluginname.dll** file into the **C:\Program Files\Motion Analysis\Cortex2\Release2.x.x.x** folder and relaunching **Cortex**.

Figure 10-1. Plugins Tab



Current Directory: C:\Program Files\Motion Analysis\Cortex2\Samples\BioFeedTrak\GolfSwing

Snippet: 1

Translate X: 0.0
Translate Y: 0.0
Translate Z: 0.0
Rotate X: 0.0
Rotate Y: 0.0
Rotate Z: 0.0
Scale: 1.0

☑ Refit Identifying Template
☑ Update Model Pose Markers
☑ Update Model Pose

Frame offset: 1

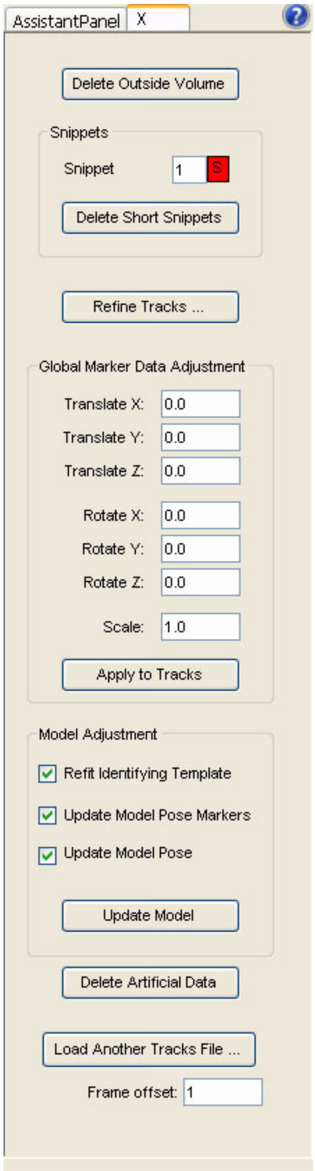
16 - Stopped | 921 Frames | 120 FPS | Z-Up | Units:mm | Analog: 600.00 Hz

File
Layouts
Data Views
Tools
Help
MotionAnalysis
Browse...
System
Calibration
Motion Capture
Post Process
Model Edit
Plugins
Presentation
AssistantPanel
X
Rectify Unnamed
Quick ID
Rectify
Create Template...
Template ID
Template Rectify
RB Rectify
Marker ID
Exchange
Linear Join
Cubic Join
RB Join
Virtual Join...
Calc VMs
Smooth
Make Unnamed
Delete Unnamed
Copy
Cut
Cut Outside
MarkerSets:
New...
Add...
Quick Prop
Club
Golfer
Delete Outside Volume
Snippets
Delete Short Snippets
Refine Tracks ...
Global Marker Data Adjustment
Apply to Tracks
Model Adjustment
Update Model
Delete Artificial Data
Load Another Tracks File ...
VMs
Skeleton
Kinetics
Calculate
Visible
Selected
NONE

X Panel

The X panel provides a set of extra functions that are used in the post process mode.

Figure 10-2. X Panel


AssistantPanel
X
Delete Outside Volume
Snippets
S
Delete Short Snippets
Refine Tracks ...
Global Marker Data Adjustment
Apply to Tracks
Model Adjustment
Update Model
Delete Artificial Data
Load Another Tracks File ...

Snippet 1

Translate X: 0.0
Translate Y: 0.0
Translate Z: 0.0

Rotate X: 0.0
Rotate Y: 0.0
Rotate Z: 0.0

Scale: 1.0

☑ Refit Identifying Template
☑ Update Model Pose Markers
☑ Update Model Pose

Frame offset: 1

Delete Outside Volume

Eliminates all marker data outside of the volume defined in Calibration Details.

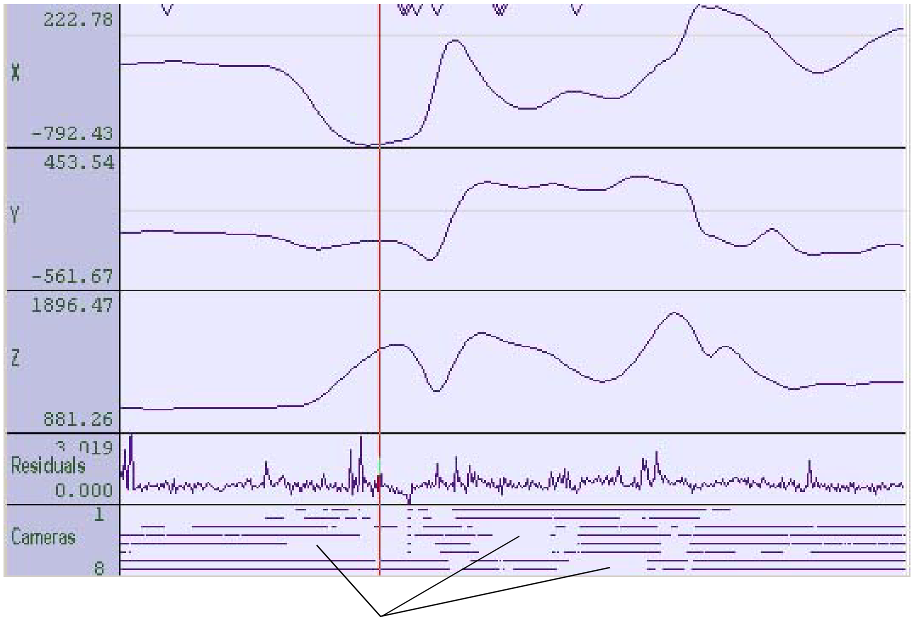
Snippets/Delete Short Snippets

Deletes data strings (in frames) that are shorter than a specified length.

Refine Tracks

This feature will smooth data that has become jumpy due to camera on/off noise. When a camera is turned on and off, there is at times a small data spike in the frames before the camera is turned off and after it is on. This is useful on facial data where small increments (< 1 mm) will have a significant effect on the final results (animated character).

Figure 10-3. Refine Tracks

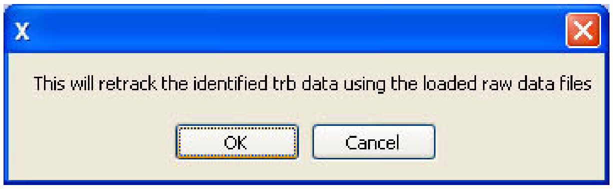


Missing data to be smoothed

To Refine Tracks you will need to:

3. Load a Capture with tracks that are identified. Only identified tracks are refined. Unnamed marker data is not affected.
4. Select **X Panel > Refine Tracks...** The message appears as shown in Figure 10-4.

Figure 10-4. Retracking Identified TRB Data Message



This will retrack the identified trb data using the loaded raw data files

5. Select **OK**.
6. Select **File > Save Capture** (if you want to save the results).

Global Marker Data Adjustments

The Global Marker Data Adjustment section allows the user to modify the tracks data by translating, rotating, and/or scaling the data. This is an operation that applies to all marker data over all the tracks. It's especially handy for converting the overall orientation of the data (such as from a Z-up coordinate system to a Y-up coordinate system).

Model Adjustment

The Model Adjustment section allows the user to update the Calcium Solver model pose data and the template model pose data simultaneously (this is the data displayed when the Show Model Pose flag is on). The marker data in the model pose is used for two different operations: as a starting pose for the template when doing a New Subject operation; and as the matching base pose for the skeleton in the Calcium Solver model. Doing both adjustments at once is important to maintaining the integrity of the data. None the less, the user is allowed to change them independently if necessary.

Refit Identifying Template

This option takes the current frame in Post Process and compares the template linkage lengths of that frame with the stored model pose. The template Min/Max values are re-calculated based on the amount of change in the linkage lengths.

Update Model Pose Markers

This check box indicates that the stored marker model pose is to be replaced with the marker data on the current frame.

Update Model Pose

This check box indicates that the stored skeleton model pose is to be replaced with the current skeleton data that has been calculated for the current frame.

These last two options are used to update the model pose of a performer between motion capture sessions (such as from one day to the next). This avoids having to spend time refitting the position of the skeleton to the new day's model pose data. The user should still verify that the fit is a good one, but if the markers on the performer have not moved by very much then the fit is likely to be good.

Update Model

The updates the model using the check-boxes as set above in the panel.

Delete Artificial Data

Deletes the Virtual Join, Cubic Join, Linear Joint, etc. data that was created for the current tracks file.

Load Another Tracks File

This merges another track trial into memory so you can view two different data trials in the 3D window. A Frame Offset lets you offset in time the merged data. Only positive offsets are allowed. It is meant for visualization of multiple data sets in the 3D window. The first trial that is loaded must have enough frames to wholly accommodate the additional trials as additional memory for any additional frames is not allocated and can cause unpredictable results. You can make one trial that has enough frames to fully accommodate all of the merged data frames and load that track data set first with the **File > Load Capture** menu item. The merged data does not get marker names or linkages unless you have a capture and marker sets defined for the additional tracks.

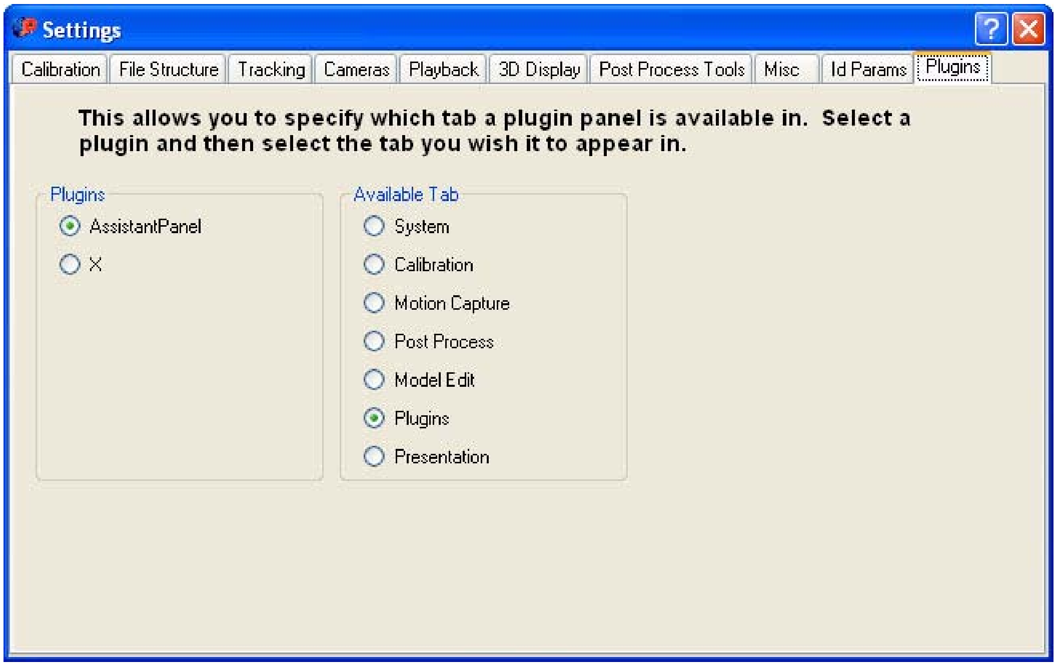
Frame Offset

This offsets the first tracks file with respect to the second. The first tracks file loaded must have enough frames to accommodate all additional tracks files. If not, unpredictable results may occur. This is intended for viewing multiple trials. To see the stick figures, multiple marker sets must exist in your current marker set.

Moving the X Panel to a New Tab

You can move the X panel to a different tab (System, Calibration, Motion Capture, etc.) with the **Settings > Plugins** tab. This provides a custom function that may help improve workflow.

Figure 10-5. Settings > Plugins Tab



This allows you to specify which tab a plugin panel is available in. Select a plugin and then select the tab you wish it to appear in.

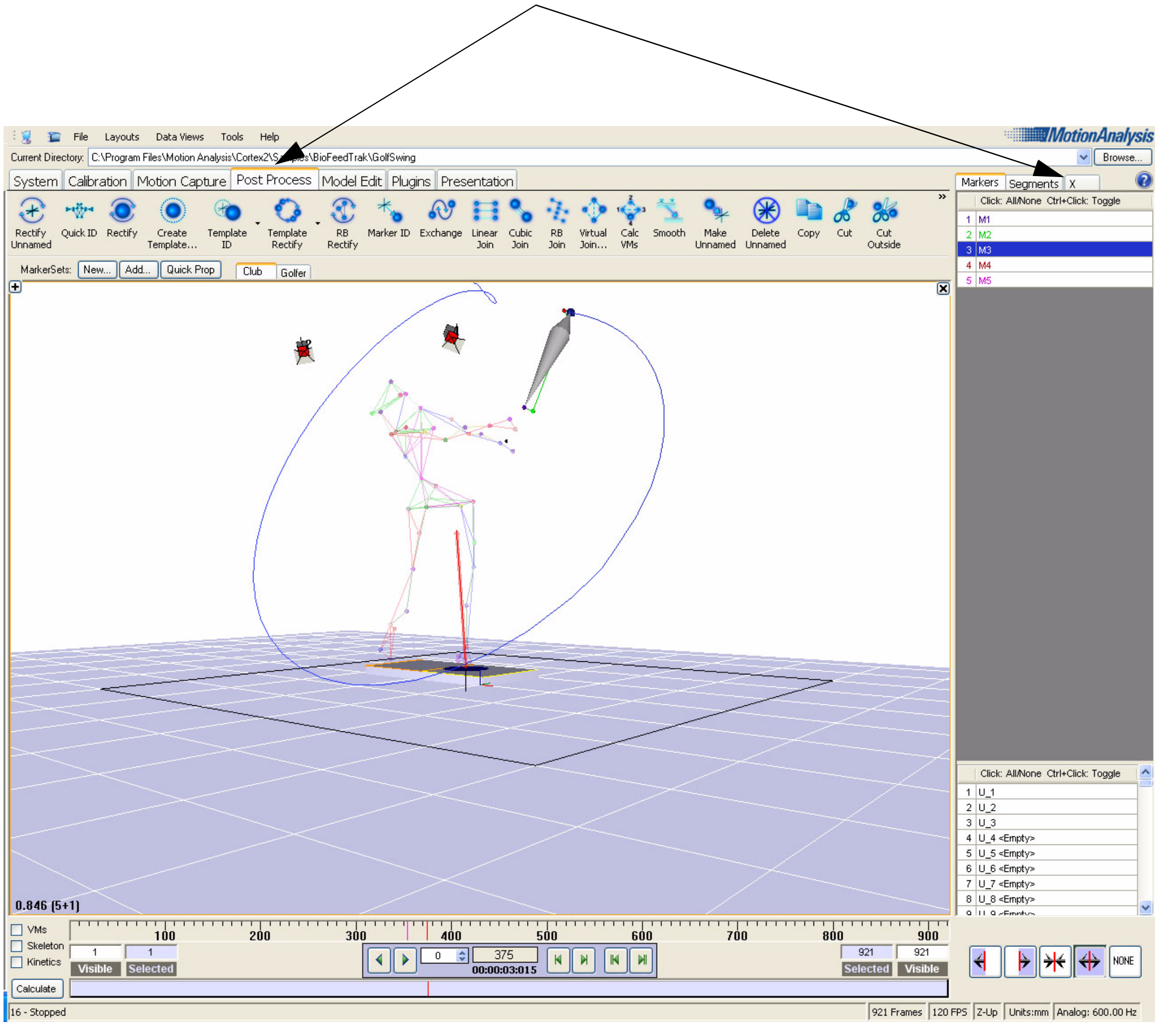
Plugins
● AssistantPanel
○ X

Available Tab
○ System
○ Calibration
○ Motion Capture
○ Post Process
○ Model Edit
● Plugins
○ Presentation

In this example, the X panel is moved to the Post Process tab (see Figure 10-6).

Figure 10-6. X Panel in Post Process Tab

The X Panel is now located in the Post Process Tab


File
Layouts
Data Views
Tools
Help
MotionAnalysis
Current Directory: C:\Program Files\Motion Analysis\Cortex2\Samples\BioFeedTrak\GolfSwing
Browse...
System
Calibration
Motion Capture
Post Process
Model Edit
Plugins
Presentation
Markers
Segments
X
Rectify Unnamed
Quick ID
Rectify
Create Template...
Template ID
Template Rectify
RB Rectify
Marker ID
Exchange
Linear Join
Cubic Join
RB Join
Virtual Join...
Calc VMs
Smooth
Make Unnamed
Delete Unnamed
Copy
Cut
Cut Outside
MarkerSets:
New...
Add...
Quick Prop
Club
Golfer
Click: All/None Ctrl+Click: Toggle
1 M1
2 M2
3 M3
4 M4
5 M5
Click: All/None Ctrl+Click: Toggle
1 U_1
2 U_2
3 U_3
4 U_4 <Empty>
5 U_5 <Empty>
6 U_6 <Empty>
7 U_7 <Empty>
8 U_8 <Empty>
0.846 (5+1)
VMs
Skeleton
Kinetics
Calculate
100
200
300
400
500
600
700
800
900
1
1
Visible
Selected
0
375
00:00:03:015
921
921
Selected
Visible
NONE
16 - Stopped
921 Frames
120 FPS
Z-Up
Units:mm
Analog: 600.00 Hz

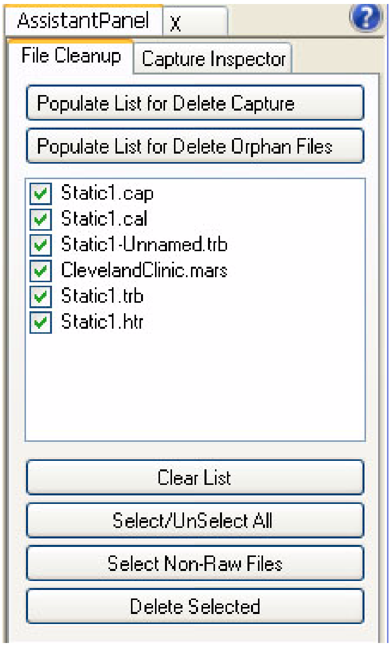
Assistant Panel

This panel is used for inspecting and modifying captures, as well as performing some disk cleanup operations. It is divided into two sections (each with its own tab): **File Cleanup** and **Capture Inspector**.

File Cleanup

This tab contains tools for deleting files from the disk. The file list is populated by selecting either the **Populate List for Delete Capture** button, or the **Populate List for Delete Orphan Files** button. The Populate List for Delete Capture will add all files that a capture references (including the cap file itself) to the delete list. The Populate List for Delete Orphan Files will scan all directories that are used by any capture in the current directory. Any file in one of those directories that is **not** a part of one of the captures is added to the delete list. This is useful in cases where MarkerSet names have changed, and old, unmanaged files have been left behind. Once the delete list is populated, individual files in the list can be selected/unselected (check box next to the file in the list). Clicking the *D***elete Selected** button will delete all files with check boxes next to them in the list. Note that this can not be undone, so proceed carefully.

Figure 10-7. Assistant Panel > File Cleanup Interface


AssistantPanel
x
File Cleanup
Capture Inspector
Populate List for Delete Capture
Populate List for Delete Orphan Files
Clear List
Select/UnSelect All
Select Non-Raw Files
Delete Selected

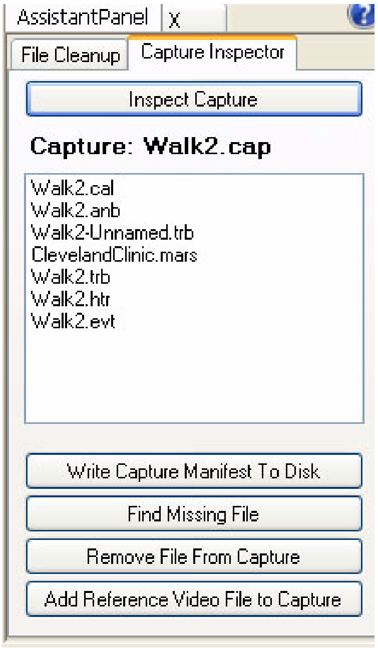
- ☑ Static1.cap
- ☑ Static1.cal
- ☑ Static1-Unnamed.trb
- ☑ ClevelandClinic.mars
- ☑ Static1.trb
- ☑ Static1.htr

Capture Inspector

This tab contains tools for looking at what is in a capture (.cap) file without having to load it into **Cortex**. The **Inspect Capture** button chooses the capture to inspect. All files in the capture are listed in the Capture section. If a file is listed in the capture, but not found on the disk, it is prefixed with “*not found*”.

In addition to inspecting the capture, some basic modification options are available. If a file in the capture is flagged as *not found*, the **Find Missing File** button will allow you to find the file in the disk. The **Remove File From Capture** button will remove an entry from the capture. For either one of these buttons, the file must be selected from the Capture section before pressing the button. The **Add Reference Video File to Capture** button is used to add additional reference videos to a capture. No length checking/modification is preformed on this file, it is just added to the cap file. Once all modifications are made to the Capture, the **Write Capture Manifest To Disk** button will write the new cap file to the disk. It can then be loaded into **Cortex**.

Figure 10-8. Assistant Panel > Capture Inspector Interface


AssistantPanel
x
File Cleanup
Capture Inspector
Inspect Capture

Capture: Walk2.cap

Walk2.cal
Walk2.anb
Walk2-Unnamed.trb
ClevelandClinic.mars
Walk2.trb
Walk2.htr
Walk2.evt

Write Capture Manifest To Disk
Find Missing File
Remove File From Capture
Add Reference Video File to Capture

Chapter 11 Skeleton Types

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Skeleton Builder (SkB) Skeletons	11-2
Calcium (Solver) Skeletons	11-2
Which Skeleton Engine Should I Use?	11-3
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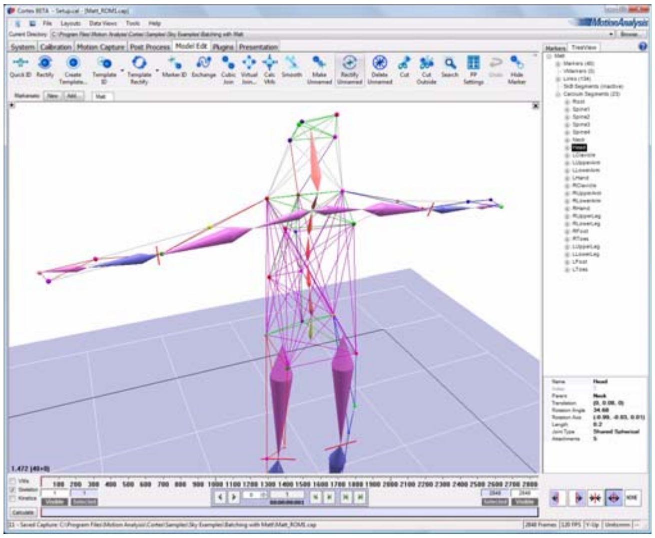
Overview

Cortex supports two kinds of skeleton calculations: **Skeleton Builder** (**SkB**) skeletons and **Calcium Solver** type skeletons. Either kind is calculated in the **Cortex** software and either can be calculated from live camera data, simulated Real Time with VC files, or from XYZ data in Post Processing. Both the marker data and the skeleton data are available to the **Talon** streaming plugins, such as the Maya and MotionBuilder Talon streaming plugins. The user can write their own plugin with the **Talon SDK** (Software Development Kit, also called SDK2) available from Motion Analysis.

Figure 11-1. Calcium Solver Integrated with Cortex



Skeleton Builder (SkB) Skeletons

Skeleton Builder (SkB) skeletons are relatively simple, direct and fast calculations of segments (bones) that are defined and calculated from one marker center to another. The markers can be real or virtual (calculated) and are typically from one virtual joint center to a second virtual joint center. A 3D local coordinate system is defined with 3 markers:

1. One marker defines the origin.
2. A second marker defines the bone axis.
3. The third marker defines the plane.

The advantage of the SkB type skeleton is that they compute very quickly and they represent the method of how most biomechanical models have been computed for many years. The disadvantage is seen when viewed on a skinned character in an animation package: The bones (segments) change length as a result of the calculation method. This is due primarily to the motion of the markers on the skin which change from frame to frame. An animated character can be set up so that the character keeps a fixed length skeleton and the skeleton is driven only by the angles measured from the skeleton. This has the visually undesirable artifact that the character’s feet will appear to slide on the floor and possibly raise above or protrude below the floor.

Calcium (Solver) Skeletons

Solver type skeletons are calculated quite differently than SkB skeletons. Solver uses the Global Optimization method of calculating the best fit of the marker data to the underlying fixed bone length skeleton. This technology was pioneered by Motion Analysis in 1990. The early version model setup was somewhat cumbersome and required physically measuring from a person’s joint centers to the marker locations before the skeleton could be used. Now, the skeletons are defined and edited within the Calcium software interface within **Cortex**. This provides a graphical way of either reading in an existing skeleton (or creating one) from an animation package such as Maya or 3DMAX. The typical way would be to create the character in the animation package and export the skeleton using an htr file using the MAC File IO plugins. The Global Optimization method is an iterative method of seeking the best fitting of the skeleton within the “marker cloud” of identified markers. The results are quite astounding: the animated characters motions derived from this method is very good. Final editing of the htr skeleton motion data can be done within the animation package or with a third party tool, such as MotionBuilder.

Which Skeleton Engine Should I Use?

SkB skeletons are good for most biomechanical applications and have been the norm there for many years. They are also used for animation customers who want tools for quick pre-visualizations of your characters motions.

For the final cut and the big screen presentations, where details matter and looks are everything, you will be glad to have your Calcium (Solver) skeletons under the skin of your final characters.

Cortex Skeleton Engine Selection

The Engine Selection sets the method of calculating the (optional) skeleton model that can be calculated in **Cortex**. There are two main skeleton engines available from Motion Analysis: Skeleton Builder and Calcium (Solver). **Cortex** will run any skeleton engine that has been previously defined without any additional licenses. To define or edit the skeleton definitions, you need the Skeleton Builder or Calcium license items.

The skeleton model is saved with your marker set information in the MARS file. The **File >Add MarkerSet...** menu item will load the skeleton along with all the other markerset information.

Post Process Skeletons

Skeletons can also be calculated in the Post Processing tab from your current XYZ data that is visible in the 3D and XYZ data views.

SkB Skeleton Builder Skeletons

Skeleton Builder (SkB) skeletons are always calculated if the **SkB Skeleton Builder** option is selected. You can see the Skeleton by selecting **Show Skeleton** from the right mouse menu in the 3D data view. If you are using one of the streaming plugins, like the Maya Talon plugin or the MotionBuilder plugin, both the marker data and the calculated skeleton is available to drive your animated character from either the Real Time or Post Processing mode.

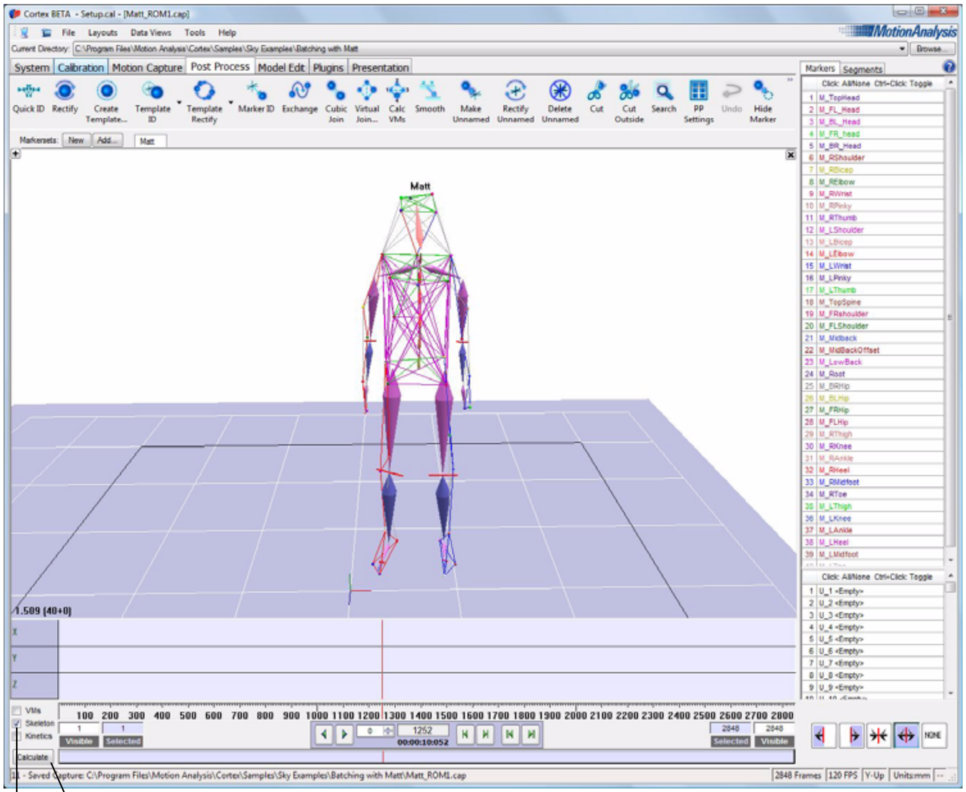
Calcium Solver Skeletons

The Calculate button (refer to Figure 11-2) activates the Solver engine to do the Global Optimization method and solve for the skeleton within the marker cloud. If you have defined a Calcium Solver Skeleton in Post Processing, the process is as follows:

1. Select the Skeleton check-box.
2. Define a period of frames (select a starting and end frame) to calculate from the current time slider.
3. Click on the **Calculate** button.

Note: The Treeview has an option to view the Skeleton as it renders.

Figure 11-2. Skeleton Check-Box and Calculate Button


Cortex BETA - Setup.cal - [Matt_ROM1.cap]
File
Layouts
Data Views
Tools
Help
MotionAnalysis
System
Calibration
Motion Capture
Post Process
Model Edit
Plugins
Presentation
Markers
Segments
Matt
VMs
Skeleton
Kinetics
Calculate

Calculate Button

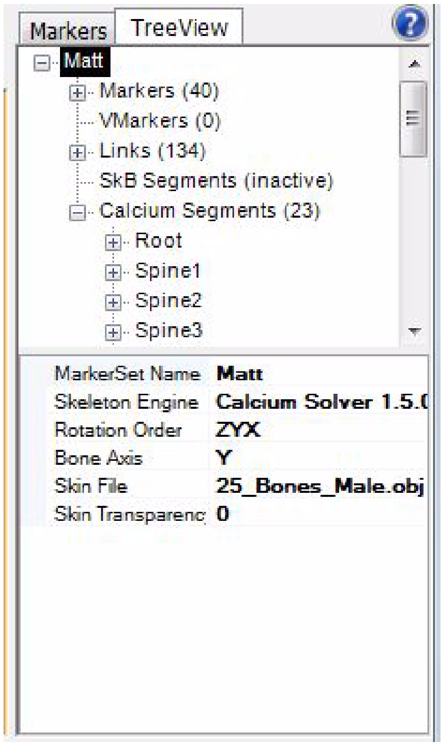
Skeleton Check-Box

This can take several seconds to minutes, depending on the length and complexity of the skeleton. If you are using one of the streaming Talon plugins, the skeleton data is available after the calculations are finished. You can scrub back and forth in the Post Processing mode or press the **Play** button and both the marker data and the skeleton (htr type) data are available to the streaming Talon plugins (like Maya).

Skeleton Option Details (as selected from Tree View)

The type of skeleton is chosen from the attributes section of the top level of the TreeView.

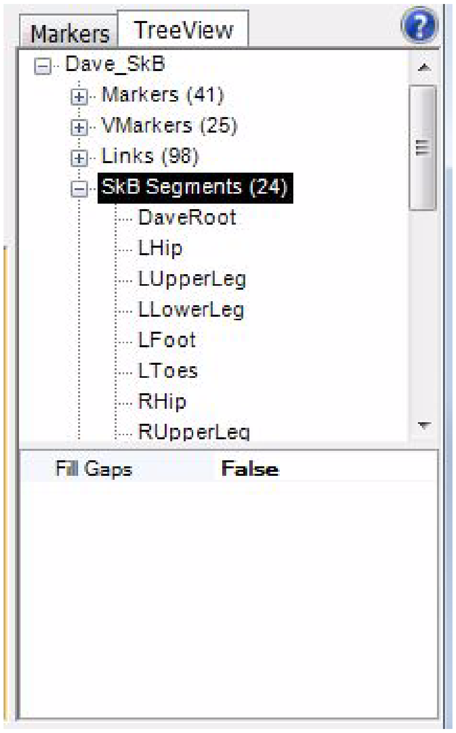
Figure 11-3. The Top Level of Tree View


Markers
TreeView
Matt
Markers (40)
VMarkers (0)
Links (134)
SkB Segments (inactive)
Calcium Segments (23)
Root
Spine1
Spine2
Spine3

MarkerSet Name	Matt
Skeleton Engine	Calcium Solver 1.5.
Rotation Order	ZYX
Bone Axis	Y
Skin File	25_Bones_Male.obj
Skin Transparenc	0

Skeleton Builder (SkB) Engine

Figure 11-4. The Top Level of Skeleton Builder

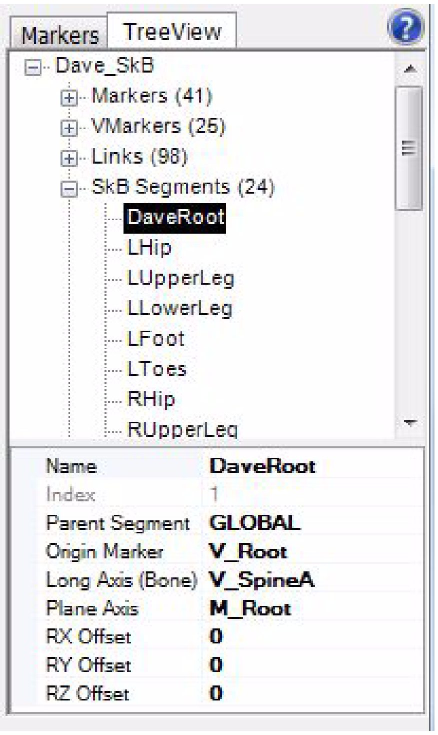


- Dave_SkB
  - Markers (41)
  - VMarkers (25)
  - Links (98)
  - SkB Segments (24)
    - DaveRoot
    - LHip
    - LUpperLeg
    - LLowerLeg
    - LFoot
    - LToes
    - RHip
    - RUpperLeg

Fill Gaps **False**

Bone segments are defined from one marker to another, typically virtual markers that represent joint centers. The advantage to this method is the fast and direct calculations from markers to joint centers to bone segments. The disadvantage is primarily for high resolution animation use since the joint centers are calculated directly from real and virtual marker locations. Bone lengths will vary slightly from frame to frame due to marker-skin motion which can cause the animated character’s skin to distort and not look as good as expected.

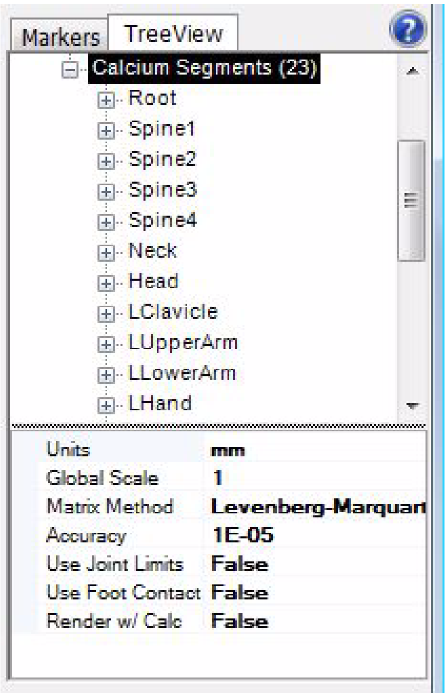
Figure 11-5. Skeleton Builder Bone Attributes


Markers
TreeView
Dave_SkB
Markers (41)
VMarkers (25)
Links (98)
SkB Segments (24)
DaveRoot
LHip
LUpperLeg
LLowerLeg
LFoot
LToes
RHip
RUpperLeg

Name	DaveRoot
Index	1
Parent Segment	GLOBAL
Origin Marker	V_Root
Long Axis (Bone)	V_SpineA
Plane Axis	M_Root
RX Offset	0
RY Offset	0
RZ Offset	0

Calcium Solver

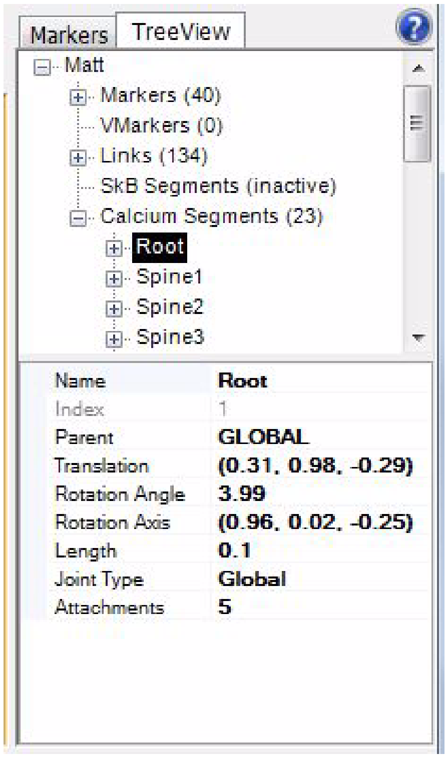
Figure 11-6. The Top Level of Calcium


Markers
TreeView
Calcium Segments (23)
Root
Spine1
Spine2
Spine3
Spine4
Neck
Head
LClavicle
LUpperArm
LLowerArm
LHand

Units	mm
Global Scale	1
Matrix Method	Levenberg-Marquart
Accuracy	1E-05
Use Joint Limits	False
Use Foot Contact	False
Render w/ Calc	False

This is a very different method of calculating the skeleton motion from marker locations. Typically, the skeleton is defined within one of the several animation packages and exported and saved in an HTR file. This skeleton is not allowed to change size to fit the motion data, but the Solver engine software uses a best fit Global Optimization of the marker data to conform to the rigid underlying skeleton. This results in the very best way of animating characters from mocap data. The **Calcium** software allows you to export a .mod file. The Solver Global Optimization method is resident in three of Motion Analysis Corporation's software products: **Cortex, Calcium**, **Sonic,** and the **SIMM** modeling package.

Figure 11-7. Calcium Bone Attributes


Markers
TreeView
Matt
Markers (40)
VMarkers (0)
Links (134)
SkB Segments (inactive)
Calcium Segments (23)
Root
Spine1
Spine2
Spine3

Name	Root
Index	1
Parent	GLOBAL
Translation	(0.31, 0.98, -0.29)
Rotation Angle	3.99
Rotation Axis	(0.96, 0.02, -0.25)
Length	0.1
Joint Type	Global
Attachments	5

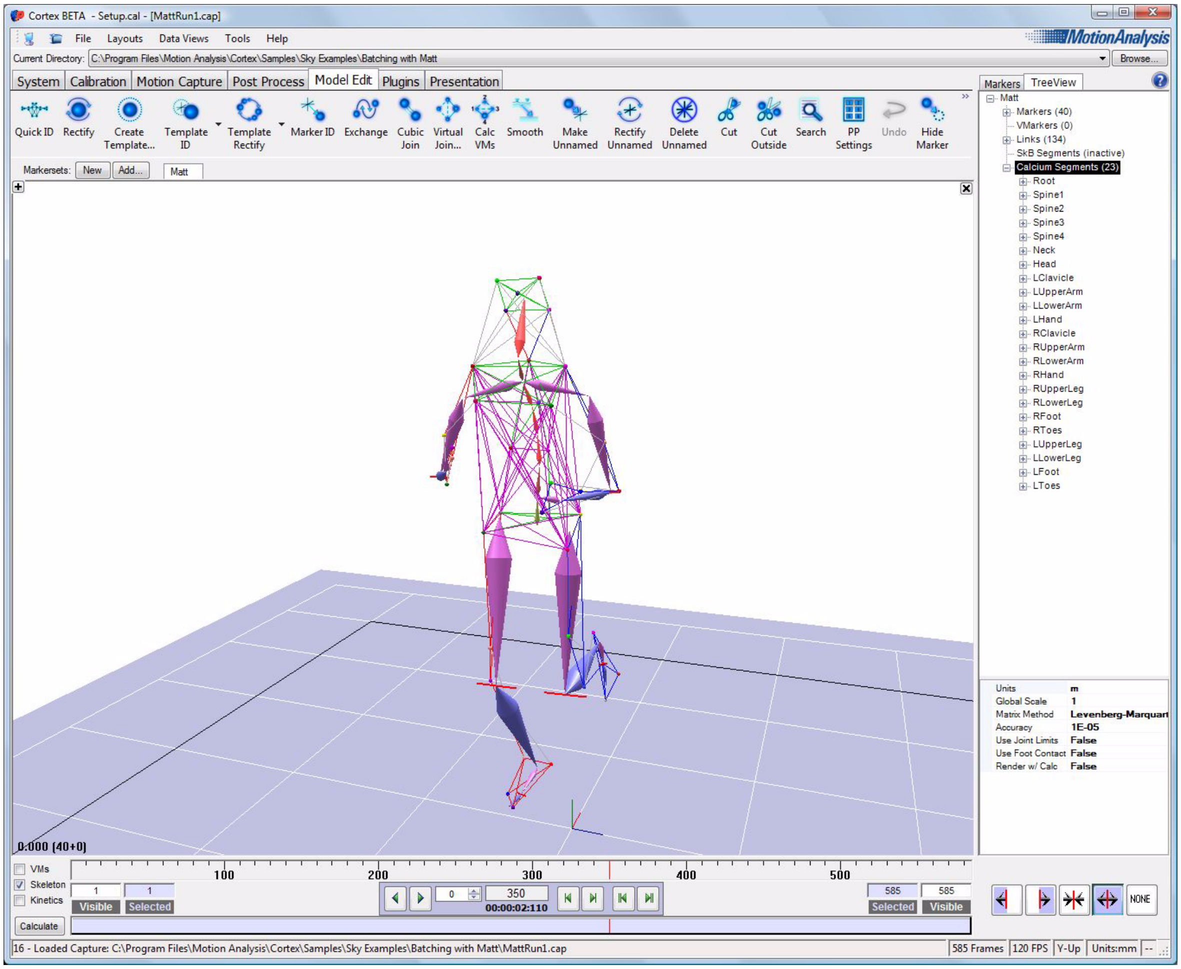
SIMM Calcium Model

This uses the Solver engine with the same advantages as the **Calcium** Solver method above, but with a known and fixed marker set that was developed for biomechanics use. To use it, you must use some variation of the **OrthoTrak** marker set, which has several required markers (such as the Knee, Ankle, Hip and Shoulder markers) and many optional markers that will introduce more detail and more bone segments into the solution. The big advantage over the **Calcium** Solver model is that you do not need to create a MOD file, which means that you do not need to use or learn the **Calcium** software. **Cortex** creates an even more thorough JNT (joint) file when you export the SIMM Calcium Model. You do need to have the person standing in a neutral pose (typically with the arms out in a T-pose, feet slightly apart and thumbs forward).

Model Edit > TreeView

The Skeleton Engine type is displayed and can be edited in the **Model Edit > TreeView** panel when you select the prj name at the root of the Tree View. The Skeleton Engine type appears as the Value of the Skeleton Engine Property at the bottom of the Tree View panel.

Figure 11-8. Model Edit TreeView


Cortex BETA - Setup.cal - [MattRun1.cap]
File
Layouts
Data Views
Tools
Help
MotionAnalysis
Current Directory: C:\Program Files\Motion Analysis\Cortex\Samples\Sky Examples\Batching with Matt
Browse...
System
Calibration
Motion Capture
Post Process
Model Edit
Plugins
Presentation
Quick ID
Rectify
Create Template...
Template ID
Template Rectify
Marker ID
Exchange
Cubic Join
Virtual Join...
Calc VMs
Smooth
Make Unnamed
Rectify Unnamed
Delete Unnamed
Cut
Cut Outside
Search
PP Settings
Undo
Hide Marker
Markersets:
New
Add...
Matt
Markers
TreeView
Matt
Markers (40)
VMarkers (0)
Links (134)
SkB Segments (inactive)
Calcium Segments (23)
Root
Spine1
Spine2
Spine3
Spine4
Neck
Head
LClavicle
LUpperArm
LLowerArm
LHand
RClavicle
RUpperArm
RLowerArm
RHand
RUpperLeg
RLowerLeg
RFoot
RToes
LUpperLeg
LLowerLeg
LFoot
LToes
0:000 (40+0)
VMs
Skeleton
Kinetics
Calculate
1
1
Visible
Selected
100
200
300
400
500
0
350
00:00:02:110
585
585
Selected
Visible
NONE
585 Frames
120 FPS
Y-Up
Units:mm

Units	m
Global Scale	1
Matrix Method	Levenberg-Marquart
Accuracy	1E-05
Use Joint Limits	False
Use Foot Contact	False
Render w/ Calc	False

16 - Loaded Capture: C:\Program Files\Motion Analysis\Cortex\Samples\Sky Examples\Batching with Matt\MattRun1.cap

Exporting the Skeleton Data Into an HTR File

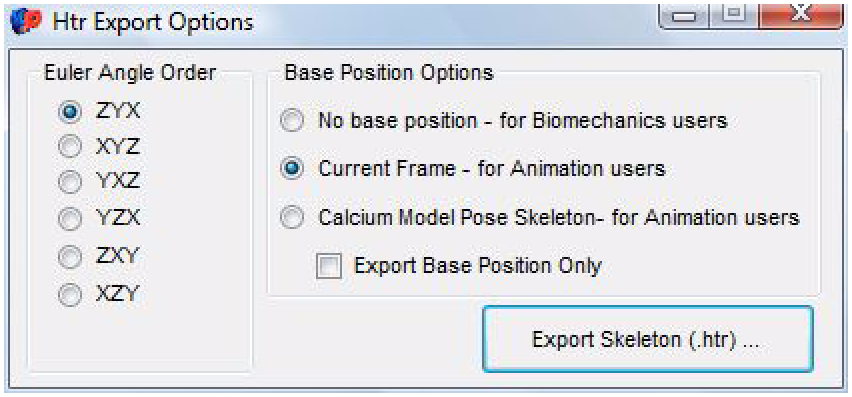
The **SkB** or Solver type skeleton data can be saved to an HTR (hierarchical translations and rotations) file after you calculate it and view it in **Cortex**. Select the **File > Export HTR file...** menu item. This is for use with animation packages. You will then select the default top Euler Angle Order (ZYX) since that is how the plugins are built to receive the data.

The following are options on the Export HTR file menu:

Euler Angle Order

Use ZYX (which is the default) if you are going to import this with a Motion Analysis File IO plugin to the animation packages. Other Euler Angle orders will be decided by your local mathematicians. The numbers in the **Cortex** software are stored internally in a certain way and exported to the HTR file according to the method above.

Figure 11-9. HTR Export Options



Htr Export Options

Euler Angle Order
● ZYX
○ XYZ
○ YXZ
○ YZX
○ ZXY
○ XZY

Base Position Options
○ No base position - for Biomechanics users
● Current Frame - for Animation users
○ Calcium Model Pose Skeleton- for Animation users
☐ Export Base Position Only

Base Position Options

Angles in the columns of HTR data are absolute angles according to the coordinate systems defined. This is typically used by biomechanics and research customers.

Current Frame

The absolute angles in the currently selected frame are written out in the file header of the HTR file. The angles in the columns are zero referenced to the angles in the file header. Use this method option if you are going to read the htr files into an animation package with the Motion Analysis File IO plugins.

Licensing Notes

SkB skeletons are defined and edited within the **Cortex** software and require a separate license item, but they can be run and the skeletons data generated without additional licenses in **Cortex**. There is separate documentation provided with the Skeleton Builder that shows how to set up and edit **SkB** skeletons.

Calcium Solver skeletons are imported or created in the **Calcium** software. **Calcium** software requires a separate license to edit or create the skeletons, but they too can be run and the skeleton data created from **Cortex** without a separate license. **Calcium** also can create the HTR skeleton data using the same Solver engine as **Cortex** and the **SIMM Motion Module.**

Multiple Characters and Multiple Skeletons

When you specify additional marker sets, the skeleton engine needs to be in each of the markerset files that you select. The skeleton type is stored in the markerset file. For previously stored MARS files, open up each of the MARS files separately, **Tree View** panel, and specify the appropriate skeleton engine, then save out the MARS file.

In the **Motion Capture > Objects** panel, you can select whatever set of MARS file you need for tracking and solving a particular capture. All the skeleton information for the capture is saved in the MARS files and references to all the files are kept in the capture file.

Chapter 12

Sky Scripting Interface

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Installation File Structure	12-1
The Registry	12-2
The Script Object	12-2
Script Examples	12-2
Updating Old Sky Files	12-3
Graphical User Interface	12-4
Sky Compiled Script Reference	12-8

Overview

Sky is the name of the scripting interface for **Cortex**. It’s graphical interface provides the user access to **Cortex** functionality within a Visual Basic/.NET language environment. Sky is intended as a tool for users to encapsulate elements of repetitive tasks such as file processing, data editing and parameter setting. This tool is intended for users who have some general knowledge of scripting and programming. Sky provides added functionality using the .NET architecture, giving the user access to a considerably enhanced feature set, and the execution speed of a compiled script.

Installation File Structure

Sky is integrated with **Cortex** and uses the UserFiles folder to store scripts and documentation.

- **UserFiles/SkyFiles**—Contains the list of Global Sky functions. This is the root of the Sky folder structure.
- **UserFiles/SkyFiles/CopyPerProject**—This folder contains the Sky files (which you are encouraged to add to) that will get copied to any current working folder using the "CopyPerProject" toolbar button.
- **UserFiles/SkyFiles/SkyDocs**—Contains the Sky documentation files. The root folder contains this document while the sub-folder **SkyFunctions** contains an RTF file for each Sky function.

The Registry

Sky stores two keys in the Windows Registry under **HKEY_LOCAL_MACHINE\SOFTWARE\Motion Analysis\Sky**. The first key is "Network Folder" and saves the path for the Network Sky Scripts list box. The second key is "StartupScript" and saves the filename of the Sky script to run when Sky is opened for the first time. These scripts apply to the computer and will be the same for all users.

The Script Object

The scripting language is Visual Basic. Sky loads the script into the VB Compiler which compiles then executes the script code. You can create and use variables, subroutines and functions in Visual Basic. As a compiled assembly, the script variables are only defined during execution of the script (when you run the script). For a more detailed description of how to combine multiple operations into one script run, refer to "Sky Compiled Script Reference" on page 12-8.

Script Examples

Sample scripts with data are found under the **Cortex** installation folder under **Samples\SkyExamples**.

Updating Old Sky Files

The Sky scripting language, based on Visual Basic, is pretty much the same as previous versions (the first version for EVaRT was called "Sky" and this section is mostly meant to describe how the current version is different from that. The second version of Sky for Cortex 1 was called "Sky2" to avoid confusion with the EVaRT version, the most recent version of Sky for Cortex2 is back to being called "Sky" and is almost identical to Sky2 with the exception of new commands added to implement Cortex2 features), but there are a few small differences based on how Sky invokes the Script object. The most important difference is that the main execution of the script is contained within a subroutine named SkyMain. Other subroutines can be defined and used within the script, but the actions of the script need to be contained in a SkyMain subroutine. The first version of Sky required a Main subroutine, this is now reserved for the compiler, and using Sub Main will cause a compiler error.

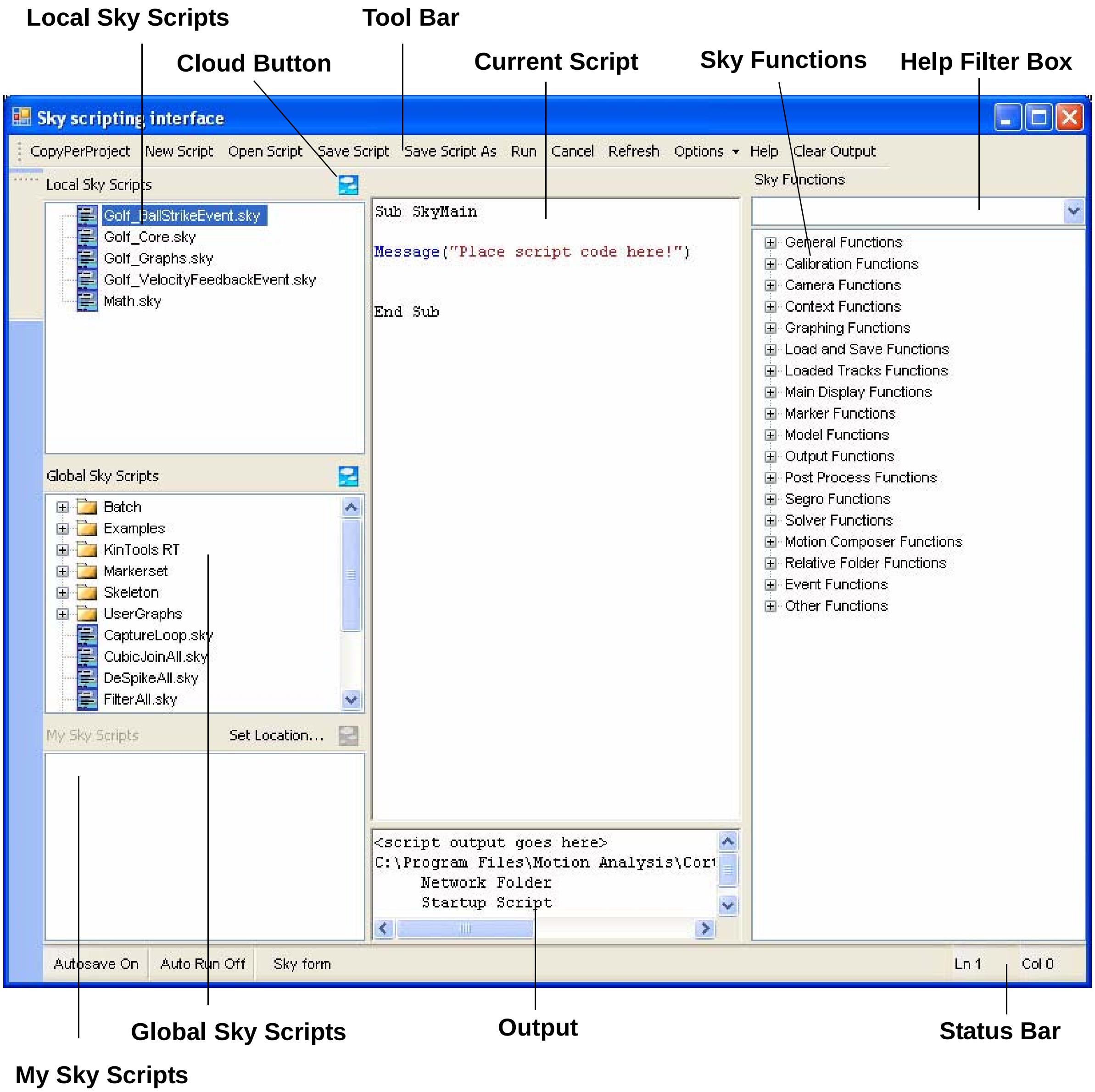
For example:

```
'
' FindAutoIDFrame -
'
' Increment frames and keep calling AutoID until a marker
gets identified.
' This assumes no markers were identified before being
called.
'
sub SkyMain
       swPopups_SetQuietMode(1)
       iHi = swLoadedTracks_GetNumberOfFrames() -1
       for i = 0 to iHi
             swLoadedTracks_SetFrameNumber(i)
             swPost_AutoID()
             iResult = swContext_GetMarkerPosition(0,x,y,z)
             if iResult = 0 then
                    Message( "AutoID found at frame+CStr(i))
                    exit sub
             end if
             if swCancelled() then
                    Exit Sub
             end if
       next
       swPopups_SetQuietMode(0)
end sub
```

Graphical User Interface

The user interface for Sky is found under the **Cortex** Tools menu.

Figure 12-1. Sky Graphical User Interface in Cortex


Local Sky Scripts
Tool Bar
Cloud Button
Current Script
Sky Functions
Help Filter Box
Sky scripting interface
CopyPerProject
New Script
Open Script
Save Script
Save Script As
Run
Cancel
Refresh
Options
Help
Clear Output
Local Sky Scripts
Golf_BallStrikeEvent.sky
Golf_Core.sky
Golf_Graphs.sky
Golf_VelocityFeedbackEvent.sky
Math.sky
Global Sky Scripts
Batch
Examples
KinTools RT
Markerset
Skeleton
UserGraphs
CaptureLoop.sky
CubicJoinAll.sky
DeSpikeAll.sky
FilterAll.sky
My Sky Scripts
Set Location...
Sky Functions
General Functions
Calibration Functions
Camera Functions
Context Functions
Graphing Functions
Load and Save Functions
Loaded Tracks Functions
Main Display Functions
Marker Functions
Model Functions
Output Functions
Post Process Functions
Segro Functions
Solver Functions
Motion Composer Functions
Relative Folder Functions
Event Functions
Other Functions
Autosave On
Auto Run Off
Sky form
Ln 1
Col 0
Global Sky Scripts
Output
Status Bar
My Sky Scripts

```
Sub SkyMain

Message("Place script code here!")


End Sub
```

```
<script output goes here>
C:\Program Files\Motion Analysis\Cort
     Network Folder
     Startup Script
```

Toolbar

Copy Per Project—Copies Sky files from the folder **MAC_DIR/UserFiles/SkyFiles/CopyPerProject** to the current working capture directory. This makes it easy to initialize a new capture with your favorite scripts. Will not overwrite existing scripts of the same name.

New Script—Clear the Script text editor and start editing a new script.

Open Script—Bring up a file browser to find a sky file not in the same directory.

Save Script—Save the current script

Save Script As—Save the Script text to a new sky file.

Run—Execute the text in the Script editor.

Cancel—Cancel the currently executing script. This works only if the script was written to use the swCancelled Function.

Refresh—Causes Sky to refresh the Local Sky Files, Global Sky Files, Network Sky Files and clears the Input Text area by re-reading the appropriate directory.

Options—

- **Script Edit Mode—**Enable editing in the Input Text window. To run the script the Run button must be pressed (or the menu short cut "Control-r". This is the default mode. This mode is the opposite of "One Touch Execution" mode.
- **One Touch Execution—**Disable the editing in the Input Text window. In this mode Sky scripts are loaded and run immediately when selected from any of the Sky file lists.
- **Set Network Folder...—**Set the folder location for the "Network Sky Scripts" file list. This value is saved in the registry.
- **Autosave—**When on (checked) this mode causes the Sky interface to auto save the currently selected Sky file when ever the Sky file is changed, refreshed or run. This is the default mode. When off, the file is not saved at any time so the user must use "Save Script As" to save the file.
- **Reset Sky Script Object—**This clears the VB Script object of all variables and functions so it is just like when the Sky interface was first opened.
- **Colorize Text—**When on (checked) the text in the Input Text window is colorized. This is the default. When this flag is off no colorization is done. All Sky functions are shown in blue, comments are shown in green and strings are shown in red.
- **Set Startup Script...—**Specify the startup script used by Sky. This script is automatically run whenever Sky is first opened. This is where Sky buttons are saved so they can be regenerated when Sky is opened.
- **Save Startup Script—**Save the current state of the Sky interface to the specified startup script. Currently this only saves Sky button information.
- **Clear Startup Script—**Delete the startup script.

- **Run Startup Script—**Run the startup script.

Help—Brings up this help information in Internet Explorer

Local Sky Files

This contains a list of all the Sky files in the same directory as the current capture. Load a file into the script interface by single clicking on the filename. When you click a new file name, any changes you made to the currently loaded file are saved automatically (if the Autosave flag is set under the Options menu). The currently loaded file name will continue to be highlighted for as long as that file is current.

The "Cloud" button to the right of the Local Sky Files label brings up the Windows Explorer for the local folder. This makes for easy access to all the standard Windows file system browsing and editing tools.

Global Sky Files

This contains a list of all the Sky files in a standard, global directory for all the users on this computer. This directory is a sub-folder of the Userfiles folder under the **Cortex** installation folder. Load a file into the script interface by single clicking on the filename. When you click a new file name, any changes you made to the currently loaded file are saved automatically (if the Autosave flag is set under the Options menu). The currently loaded file name will continue to be highlighted for as long as that file is current.

The "Cloud" button to the right of the Global Sky Files label brings up the Windows Explorer for the global folder. This makes for easy access to all the standard Windows file system browsing and editing tools.

Any sub folders added to the Global Sky Files folder will appear in the list as sub folders. This allows for the organization of scripts by category.

Network Sky Files

This contains a list of all the Sky files in a common network directory. This location is intended to be a shared network folder accessed by users on different computers.When you click a new file name, any changes you made to the currently loaded file are saved automatically (if the Autosave flag is set under the Options menu). The currently loaded file name will continue to be highlighted for as long as that file is current.

The "Cloud" button to the right of Network Sky Files label brings up the Windows Explorer for the network folder. This makes for easy access to all the standard Windows file system browsing and editing tools.

Input Text

The Input Text area displays the currently loaded script. This is what will be run when the Run button is pressed.

Right clicking in the Input Text window brings up a menu of editing tools:

- **Undo—**One level of undo is available in the Input Text window.
- **Cut—**Standard text operation.
- **Copy—**Standard text operation.
- **Paste—**Standard text operation.
- **Delete—**Standard text operation.

- **Run—**Runs the script (Same as the Run button in the Toolbar)
- **New Script—**Same as "New Script" operation in the Toolbar.
- **Open Script—**Same as "Open Script" operation in the Toolbar.
- **Script Save As...—**Same as "Save Script As" operation in the Toolbar.

Output

Displays output from the scripting engine. Error messages from the scripting engine will be displayed as well as any text messages from the script. The output text area is refreshed when a new file is loaded. All help information for Sky functions are displayed here as well.

Drag And Drop

Drag and drop features are implemented in a number of areas in the Sky interface:

- Dragging and dropping a Sky file onto the Input Text area automatically generates the Sky command that will run the dragged script when the current script is run.
- Dragging and dropping a Sky file onto the toolbar creates a Sky button that, when pressed, will execute the script that was dragged onto the toolbar. These buttons will be saved in the Startup script (see the Options menu description above) when you select "Save Startup Script".
- Dragging and dropping a Sky function name from the list on the right onto the Input Text area will drop the function name onto the script.
- Dragging and dropping a Sky file from one list to another will copy that file from the original location to the dragged one. If a script of that name already exists then nothing happens.
- Text from the output area (especially sample Sky commands from the Example section) can be dragged onto the Input Text area.

Sky Functions

The scripting functions (for the most part) in Sky are simple wrappers for functions found in the **Cortex** .dll. Any call you make is immediately passed on to the corresponding core function in **Cortex**. These are the same functions that the **Cortex** GUI uses at runtime so (again, for the most part) you can do just about anything through the scripting interface that **Cortex** does interactively.

All the script functions have the same name as the corresponding .dll function call except a "sw" has been added to the beginning ("sw" stands for "Sky Writing"). Online help for all functions is found from the Sky Functions list on the right (also, clicking on a highlighted Sky function inside the Input Text window will display help for a function).

The Sky Functions filter box will display only those Sky functions which contain the text in the filter. This makes it easy to search for functions that contain a particular name such as "Camera" or "Marker" or "Load". A drop down menu retains previously typed in filters. Only those names shown in the Sky Functions list are highlighted in the Input Text window.

The Sky Functions list is generated automatically from the internal scripting objects so the list is guaranteed to display all available Sky functions.

The functions are organized in sub-folders by category to make finding functions easier.

Status Bar

The status bar at the bottom of the window displays messages regarding operations going on in the Sky interface. The Line and Column fields display the current location of the cursor. They are convenient for locating the line in a script causing a syntax or other error in the VB Script engine.

Sky Compiled Script Reference

.NET Namespace Support

These namespaces are supported within the Sky environment are those supported in the following .NET (2.0) assemblies:

- Microsoft.VisualBasic
- System
- System.Configuration
- System.Data
- System.Data.OracleClient
- System.Data.SqlXml
- System.DirectoryServices
- System.DirectoryServices.Protocols
- System.Drawing
- System.Messaging
- System.Runtime.Serialization.Formatters.Soap
- System.Security
- System.ServiceProcess
- System.Transactions
- System.Web
- System.Windows.Forms
- System.XML

Including a Namespace

By using the appropriate Imports statement, classes from these namespaces may be used in Sky scripts.

Example:

```
‘ Sky Scripting example:

Imports System.Data.SqlClient

Imports System.Collections

‘ SqlDataAdapter is a class supported in namespace System.Data.SqlClient

Dim MySqlAdapter as SqlDataAdapter

‘ ArrayList is a class supported in namespace System.Collections

Dim MyList as ArrayList
```

Including Sky Source files

By making source files with common function, subroutine, and related variable definitions, the user can created a library of source files which can be included and used from may Sky scripts. SkyIncludeFileFunctions.sky is a very simple example of this methodology. It defines several utility file functions, SkyCopyFile, SkyDeleteFile, and SkyMoveFile. By including SkyIncludeFileFunctions in a script with the Include keyword, the functions within it may be used in the script.

Example:

```
Include SkyIncludeFileFunctions.sky

SkyMain

…

Dim bForceOverwrite as Boolean = True

CopyFile("SourceFile.txt", "DestFile.txt", bForceOverwrite)

CopyFile("Source2.txt", "Dest2.txt")

…

End Sub
```

Any Sky source file intended to be used as an include file should NOT contain a SkyMain subroutine or a compile error will occur.

Further Resources

There is a wealth of information about Visual Basic and .NET on the internet, the interested user can find descriptions of the classes and syntax with little difficulty.

This is currently a good place to start with Microsoft:

http://msdn.microsoft.com/en-us/library/default.aspx

Searching on this Microsoft site will give the user a good place to start. Some suggested search terms:

“Visual Basic Language Specification”

“Visual Basic Language Reference”

“.NET Framework”

Appendix A

System Hardware Interconnections

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Standard Camera System Configuration	A-2
Power Consumption	A-3
CP-8 Power Hub and Ethernet Switch Connections	A-5
Camera Connections	A-6
Network Interface Cards and IP Addresses	A-7

Overview

This chapter provides information and illustrations on how to set up the hardware to be used with **Cortex**.

When using **Cortex** in the Motion Analysis motion capture system, hardware connections are straight-forward. The connection of the cameras to the CP-8 Power Hub and Ethernet Switch all have unique labeled connectors.

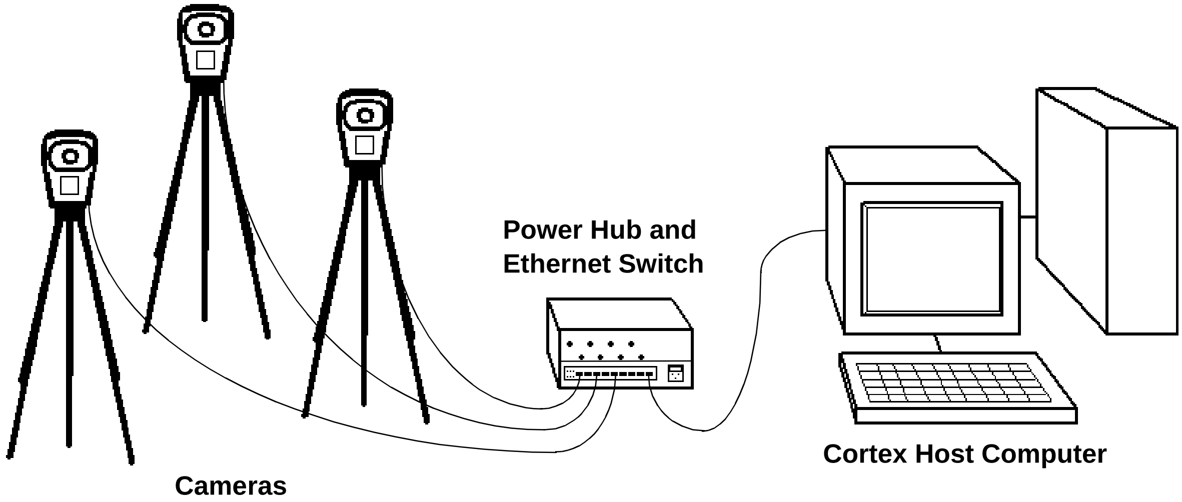
Note: Frame rate, shutter speeds, and ring light brightness for the Eagle and Hawk digital cameras are set using the **Cortex** user interface.

Note: When connecting the camera cables to the hubs/switches, you must use the end with the red indicator.

Standard Camera System Configuration

Figure A-1 shows a standard **Cortex** system setup for use with Motion Analysis digital cameras.

Figure A-1. Standard Camera System Configuration

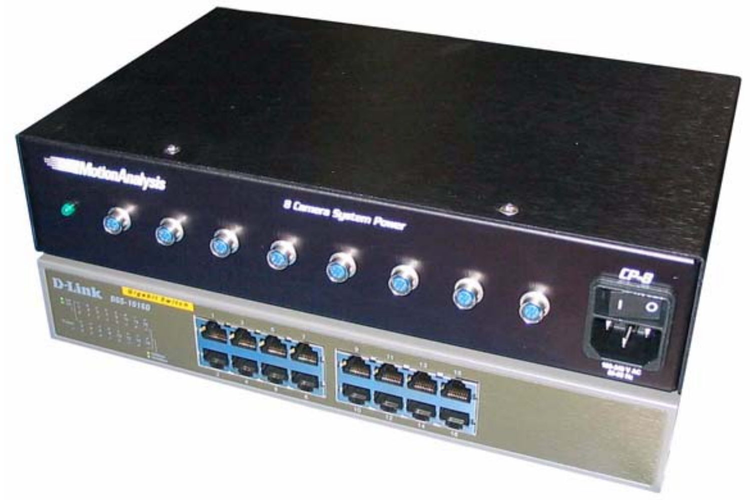

Power Hub and
Ethernet Switch
Cortex Host Computer
Cameras

For more detailed diagrams, please refer to Figures A-3 through A-10.

The main components include:

- a set of digital cameras with network and power cables for each camera
- a CP-8 Power Hub (1 for every 8 cameras) and Ethernet Switch (1 for every 15 cameras), see Figure A-2
- a Tracking Computer (host) with monitor, keyboard, and mouse

Figure A-2. CP-8 Camera Power Hub and Ethernet Switch


MotionAnalysis
8 Camera System Power
CP-8
D-Link

Power Consumption

The maximum power consumption you can expect for normal system configurations are shown in Table A-1. The actual power consumed depends on the video frame rate and the intensity of the ring lights and is usually less than that indicated.

For the most reliable system operation, it is recommended that all camera assemblies and computers be powered by an uninterrupted power supply (UPS). If you want to save your data when power is lost altogether, you will also need to power the tracking computer monitor from the UPS.

Table A-1. Power Consumption of Typical Systems

	8 Cameras	12 Cameras	16 Cameras
Power Hub/E-Net Switch with Cameras	265 W	400 W	530 W
21” SVGA Monitor	125 W	125 W	125 W
Dual Processor Computer	200 W	200 W	200 W
TOTAL	580 W	725 W	855 W

Basics of Ethernet Switches and Hubs

There is a difference between the older Ethernet hubs and the newer Ethernet switches, even though they look alike and are functionally similar. The difference is in the performance. Ethernet switches guarantee the full rated Ethernet bandwidth between all ports simultaneously, whereas the older Ethernet hubs share the bandwidth for all ports. We call the EagleHubs “hubs” to indicate that they are the center connection point for a block of cameras, but inside the EagleHub resides a switch. This performance difference is important and necessary for the camera systems to function properly.

A 100 MB Ethernet switch works well for a camera system with up to 15 cameras at a capture frame rate from 60 to 120 Hz. For larger numbers of cameras (above 16), it is important to use the 1 GB Ethernet NIC (network interface card) inside the computer and the 1 GB Ethernet switch that collects and concentrates the camera traffic to the **Cortex** Host computer.

Ethernet Tutorial and Troubleshooting Guide

There are two types of female Ethernet connections that use the same 8-pin Ethernet connector:

1. NIC-Type—The Ethernet connector that is found on the Network Interface Card on computers and on your cameras.
2. Hub-Type—The standard Ethernet plug that is found on Ethernet switches and hubs.

There are two types of Ethernet cables:

1. Standard Ethernet patch cables
2. Ethernet cross-over cables

The standard patch cable is used to connect computers to Ethernet switches.

The Ethernet cross-over cable is used for connecting Ethernet switches to other switches, unless you use the Uplink port on either switch. In this case, you can use a standard patch cable. The cross-over cable would also be necessary if you were to bypass the Ethernet switch and plug the camera directly into your computer's NIC.

Troubleshooting

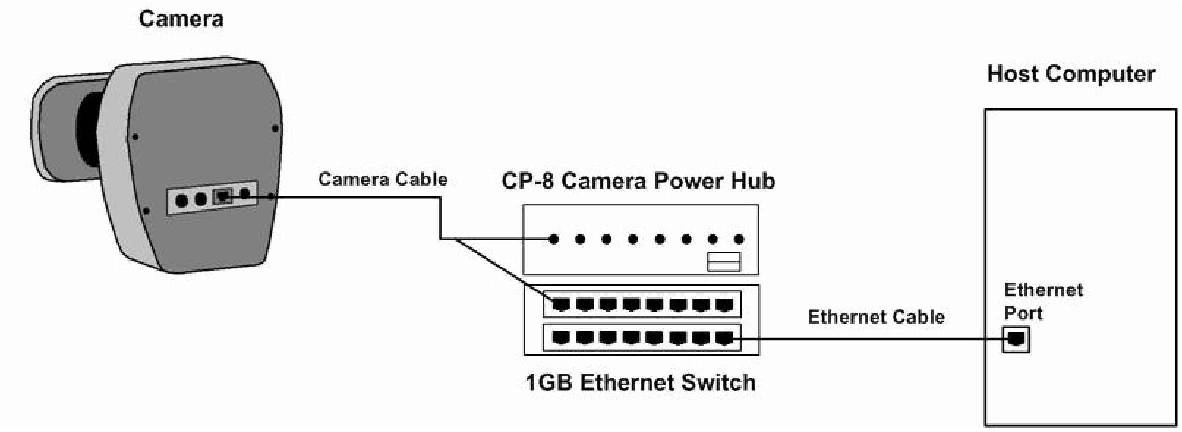
You can tell if you have a live Ethernet connection if the indicator light goes on when you plug the cable into the hub. This is also the best way to figure out whether or not your Ethernet cables are plugged in correctly. It will not damage anything if you plug in the wrong type of cable (patch or cross-over) into an Ethernet jack. For the indicator light to go on, there has to be a live Ethernet connection on both 'ends of the cables.

CP-8 Power Hub and Ethernet Switch Connections

When first setting up your Motion Analysis system, you will notice that both the power and Ethernet connections for the cameras are integrated through the CP-8 Power Hub and a 1 GB Ethernet switch. Remember, the system allows for 8 cameras per CP-8 Power Hub.

All camera power connectors are plugged into the power connectors of the CP-8 Power Hub. Order is not imperative as long as each power connector is close to an open Ethernet connector on the 1 GB Ethernet switch.

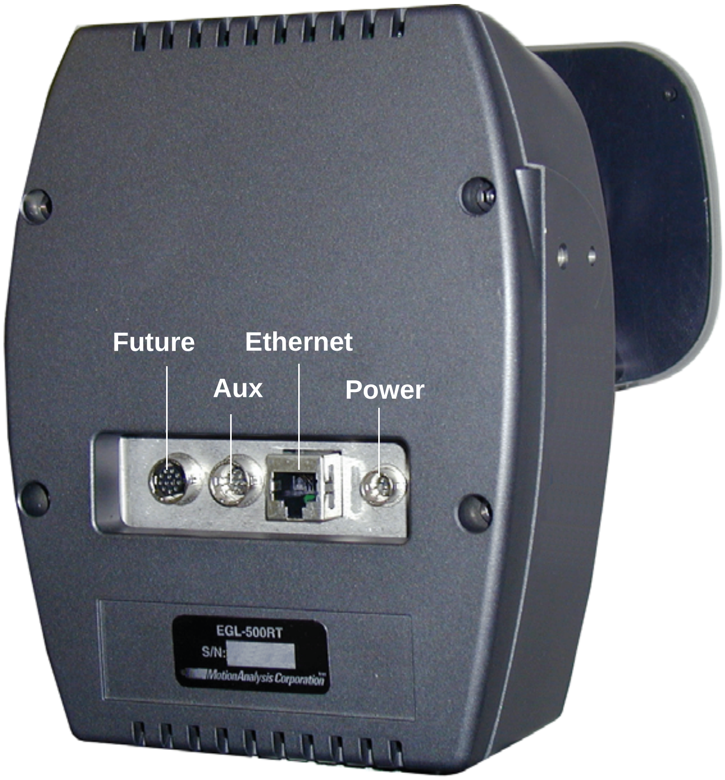
Figure A-3. Standard Digital Camera Configuration (1 to 8 Cameras)


Camera
Host Computer
Camera Cable
CP-8 Camera Power Hub
Ethernet Port
Ethernet Cable
1GB Ethernet Switch

Camera Connections

Motion Analysis digital cameras are connected to the EagleHubs using camera cables with both power and Ethernet connectors. When fitting connectors together, be sure the connections are secure and snap firmly into place.

Figure A-4. Rear Panel Connectors



Power Connector

The power connector powers the camera with a 48 Vdc source from the EagleHubs, through a CAT5 cable.

Ethernet Connector

The Ethernet connector is set for a 4-wire, full duplex 100 Mbps Ethernet.

Aux Connector

The Aux connector can be used for testing VGA and diagnostics and is generally not needed for normal customer use. An Aux cable is supplied with each Motion Analysis system which has three connectors on one end (VGA, COM 1, and BNC) for use in various applications and diagnostic testing.

Future Connector

The Future connector is reserved for future use.

Network Interface Cards and IP Addresses

It is recommended that a Motion Analysis system have two Network Interface Cards (NIC):

1. Single port for your own LAN connection
2. 4-Port dedicated to the system

Configuring a Network with Your Motion Analysis Digital Cameras

The IP addressing for the camera system is initially setup in the following manner.

- Digital Network Interface Card (NIC) = 10.1.1.199
- Subnet Mask = 255.255.255.0

This will need to be set in the “Camera Network IP Address” box in the **System > Cameras** panel.

Note: The NIC address is set from the Windows Control Panel. Select **Network Connections > Local Area Connection**, right-click **Properties > Connection** and use the following items:

- Internet Protocol (TCP/IP), Use the following IP Address: 10.1.1.199
- Subnet Mask 255.255.255.0
- DNS Server settings do not matter
- Other addresses will also work as long as you are consistent with the camera addressing and do not overlap IP addresses.

Ethernet Camera Addressing

The default camera addresses as configured when they are built start at 10.1.1.201 for camera number 1 with ascending numbers. For example:

- Camera 1: 10.1.1.201
- Camera 2: 10.1.1.202
- Camera 3: 10.1.1.203

All have sub-net masks of 255.255.255.0.

It is not necessary for the cameras to have ascending numbers. When you Connect to Cameras in **Cortex**, the software polls the network camera network and reports the number and the kinds of digital cameras.

Appendix B Analog Input Hardware and Software

Topic	Page
Overview	B-1
Installing NIDAQ Software on an Cortex Computer	B-3
Analog Signal Naming Conventions	B-4
32-Channel, 16-Bit NI USB-6218 Configuration	B-5
NI USB-6259 Analog Channel Connections	B-11

Overview

The **Cortex** system can accept analog data from external devices and synchronize it with video motion data.

Analog cards known to work with **Cortex** software include the following A-D configurations and the necessary NIDAQ software. **Cortex** will support one or two of the devices listed in Table B-1. The devices must have the same resolution (12-Bit or 16-Bit). Other NI Analog A-D input configurations should work but have not been tested.:

Table B-1. A-D Configurations Used with Cortex Software

A-D Configuration	NIDAQ Software
Win 7, Win 7-64, Vista, Vista-64	NIDAQ 9.1 or later
NI USB-6218, 32-Channel, 16-Bit (up to 6 USB devices, up to 192 channels)	NIDAQ 8.3 or later, EVaRT 5.0.4 or later NIDAQ 8.5 or later for Windows® Vista
NI PCI-6071E, 64-Channel, 12-Bit	Traditional NIDAQ 7.0 > 7.4, EVaRT 4.4
NI PCI-6071E, 64-Channel, 12-Bit (higher performance)	NIDAQ MX 8.0 or later, EVaRT 5.0
NI DAQ Card-6024E, 16-Channel, 12-Bit	Traditional NIDAQ 7.4, EVaRT 4.6
NI PCI 6254, 32-Channel, 16-Bit (up to 2 cards)	NIDAQ MX 8.0 or later, EVaRT 5.0
NI USB-6259, 32-Channel, 16-Bit (up to 2 USB devices)	NIDAQ 8.1 or later, EVaRT 5.0.2

Note: If you do not find your NI device in listed in Table B-1 on page B-1, you may need to reference older versions of the **EVaRT** User’s Manual.

Note: If you are using NIDAQ MX 8.0 or 8.1 versions and if you are collecting data for only one channel in **Cortex**, you will need to install a jumper wire from screw terminals PFI 7 to PFI 0 on the A-D interconnect box. This may be changed in future versions of the NI software drivers. If you have two analog acquisition devices installed, the same is applied for each device: If only one channel is sending data on that device, the PFI7 to PFI0 jumper must be installed. It is recommended that you upgrade to NIDAQ 9.1 or later software to avoid this problem. The latest version of the NIDAQ software can be downloaded for free from National Instruments (NI.com).

This appendix documents both of the 32-channel (16-bit) setups and the 64-channel setups of analog input available, A list of the location of channel numbers in the Analog Terminal Box for digital camera systems is given for the type of A-D setup. You may find it useful to make a copy of this chart (Table B-2 on page B-10) and use the column titled Setup Name to record the connections for your installation. The connections for a typical application using two AMTI Force Plates and ten EMG channels for digital cameras is shown for each setup.

Although connecting analog inputs is not particularly difficult, it is important that certain naming conventions be followed for the external data to work smoothly with supplementary Motion Analysis software such as **KinTools RT** and **OrthoTrak**. This is described in “Analog Signal Naming Conventions” on page B-4.

Performance Specifications

Cortex is capable of collecting up to 192 channels of analog data at any frequency between 60 and 5000 Hz. In newer systems, using the NIDAQ MX 8.0 or later software, analog rates can be much higher. The maximum rate can be up to 255 times the video capture rate, but performance may vary with different computers. The master digital camera provides the clocking signals to the A-D card in the A-D computer, which provides the phase-locking mechanism. You must connect the A-D cable from the master camera to the A-D interconnect box. Data can be collected in the pause mode or the run (live) mode, without any delay or drift between analog and video signals.

Installing NIDAQ Software on an Cortex Computer

For **Cortex 2.1** and later software, we recommend installing NIDAQ version 9.1 or later as it gives better analog performance and allows higher analog sample rates. With NIDAQ 7.1 through 7.4, the maximum analog sample rate is 5000 samples/sec for all channels. With NIDAQ 8 and above, you can go to higher rates (typically 20,000 samples per second) for all channels. Free upgrades of the NIDAQ software are available from the National Instruments website (NI.com).

Note: Cortex 2.x has not been tested with older versions of the NIDAQ software. It is known that NIDAQ version 7.5 DOES NOT WORK with any version of **Cortex**.

If NIDAQ Software is Already Installed

1. Shutdown/power OFF the computer and remove the A-D unit.
2. Power ON the computer, go to **START/Settings/Control Panel, Add/Remove Programs,** select **NI_DAQ** and then select **Remove**.
3. When complete, shutdown/power OFF the computer, wait 10 seconds, power ON the computer, let the system boot up, and then log-in when prompted. It is necessary to have the computer boot without the A-D card or software. Proceed to the next step.

New Installation of NIDAQ Software

1. Install the **NI-DAQ software, version 9.0 or later**. Note that NIDAQ version 9.1 does not work with **Cortex 2.0** or earlier versions on 64-bit Windows (**Cortex 2.1** release works on all Windows platforms). Install all of the default entities that are checked, then shutdown/power OFF the computer.
2. Power ON the computer and let it boot completely without the A-D card installed. This will complete the National Instruments software installation. Once the computer is completely booted, Shutdown/power OFF the computer once again.
3. Install the A-D unit and power ON the computer. It should come up with the Hardware Wizard and the “Found new hardware” pop-up window. At this point, the computer will automatically install the NI-DAQ drivers correctly.
4. Shutdown/power OFF the computer one last time and then power it back ON.
5. Go to the National Instruments Test and Measurements software and select Traditional NIDAQ devices and then right click and select test panel.
6. Run through some of the channels to verify that the board is seeing the data. For example, have someone step on the force plate.
7. Close and launch **Cortex** and connect to cameras. You should see that all cameras are found as well as the type of A/D unit installed.

Note: If you have NIDAQ 7.0 + drivers already installed onto your system, it is not necessary to un-install the software when upgrading.

Analog Signal Naming Conventions

When connecting force plates and EMG equipment to the **Cortex** system, certain requirements must be met and conventions followed.

Typically, force plates are connected to the first channels of the A/D system and then the EMG channels. Specific Analog signal names for the force plates must be used if **KinTools RT** and **OrthoTrak** are used. These names depend on the force plate manufacturer.

Kistler Force Plates

8 channels per plate:

- Analog Channel 1 connects to the F1X1 signal.
- Analog Channel 2 connects to the F1X3 signal, etc.

If there are two plates:

- Analog Channel 9 connects to the F2X1 signal.
- Analog Channel 16 connects to the F2Z4 signal.

The reserved names for **OrthoTrak** and **KinTools RT** are:

PLATE #1: F1X1 F1X3 F1Y1 F1Y2 F1Z1 F1Z2 F1Z3 F1Z4
PLATE #2: F2X1 F2X3 F2Y1 F2Y2 F2Z1 F2Z2 F2Z3 F2Z4

Note: These naming conventions are already set up in the Analog panel.

For AMTI or Bertec Force Plates

6 channels per plate:

- Channel 1 connects to the F1X signal.
- Channel 2 connects to the F1Y signal.
- Channel 6 connects to the M1Z signal.

If there are two plates, it connects to Channels 7 through 12. The reserved names for **OrthoTrak** and **KinTools RT** are:

PLATE #1: F1X F1Y F1Z M1X M1Y M1Z
PLATE #2: F2X F2Y F2Z M2X M2Y M2Z

EMG Signal Name Conventions

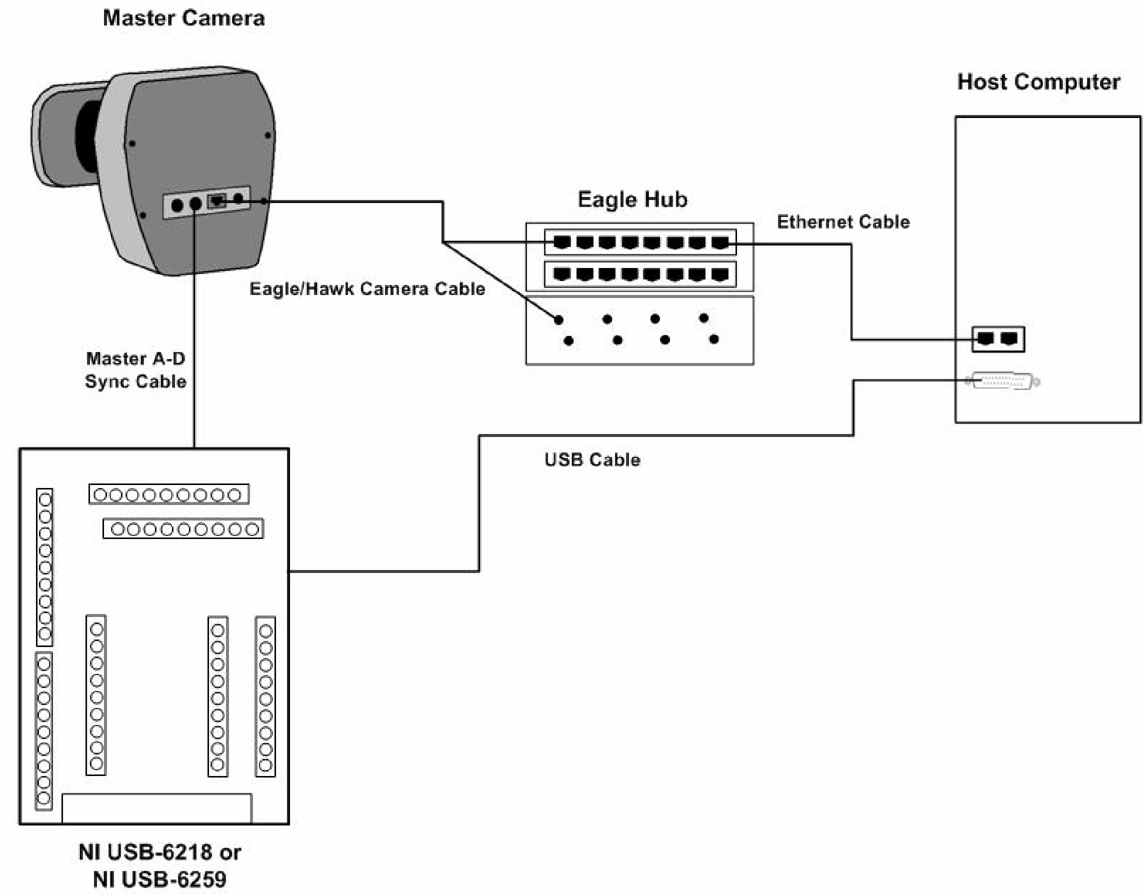
See the **OrthoTrak Reference Manual** for **OrthoTrak** muscle name conventions. The OrthoTrak muscle names are built into the analog display. They can be selected in the same manner as with the force platform manufacturer and channel.

32-Channel, 16-Bit NI USB-6218 Configuration

Note: The following has been tested on Windows XP Pro, Windows Vista, and Windows 7 with the latest web-based updates from Microsoft. The **Cortex** software will support up to 6 USB devices and up to 192 channels of analog input. USB 2.0 ports work best; USB 1.0 ports have not been tested.

Note: Up to 6 A/D devices can be installed into the host computer. The Sync Cable must be connected to all devices. A single pull-up resistor is needed for legacy cameras (Eagle/Hawk).

Figure B-1. 32-Channel, 16-Bit A-D Hardware Setup for the USB-6218 A-D


Master Camera
Host Computer
Eagle Hub
Ethernet Cable
Eagle/Hawk Camera Cable
Master A-D
Sync Cable
USB Cable
NI USB-6218 or
NI USB-6259

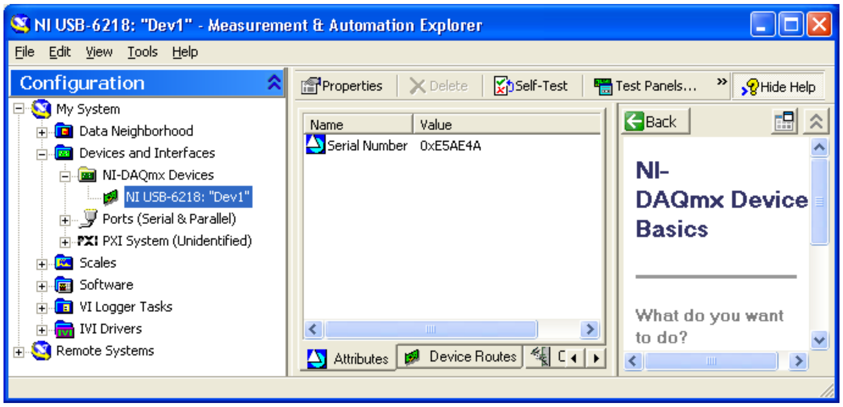
First: Install the Software

Before you plug the NI USB device into the host computer, you must first install the NI Acquisition software. For using the NI-USB 6218 A-D device, you need to have the **NIDAQ software version 8.3** (or later) installed. Run the National Instruments software installation, accept all the defaults, then let it finish and re-boot your computer. This may take 10-15 minutes. The remainder of the process takes less time. For more information, please refer back to “Installing NIDAQ Software on an Cortex Computer” on page B-3.

Second: Install the Hardware

1. Plug in the A-D device (NI USB-6218 will be used as the example below).
2. You will then automatically go through the “Found New Hardware Wizard” operation for a USB-device.

Figure B-2. NI Measurement and Automation Explorer USB-6218 Configuration Interface


NI USB-6218: "Dev1" - Measurement & Automation Explorer
File
Edit
View
Tools
Help
Configuration
My System
Data Neighborhood
Devices and Interfaces
NI-DAQmx Devices
NI USB-6218: "Dev1"
Ports (Serial & Parallel)
PXI System (Unidentified)
Scales
Software
VI Logger Tasks
IVI Drivers
Remote Systems
Properties
Delete
Self-Test
Test Panels...
Hide Help
Back
Attributes
Device Routes

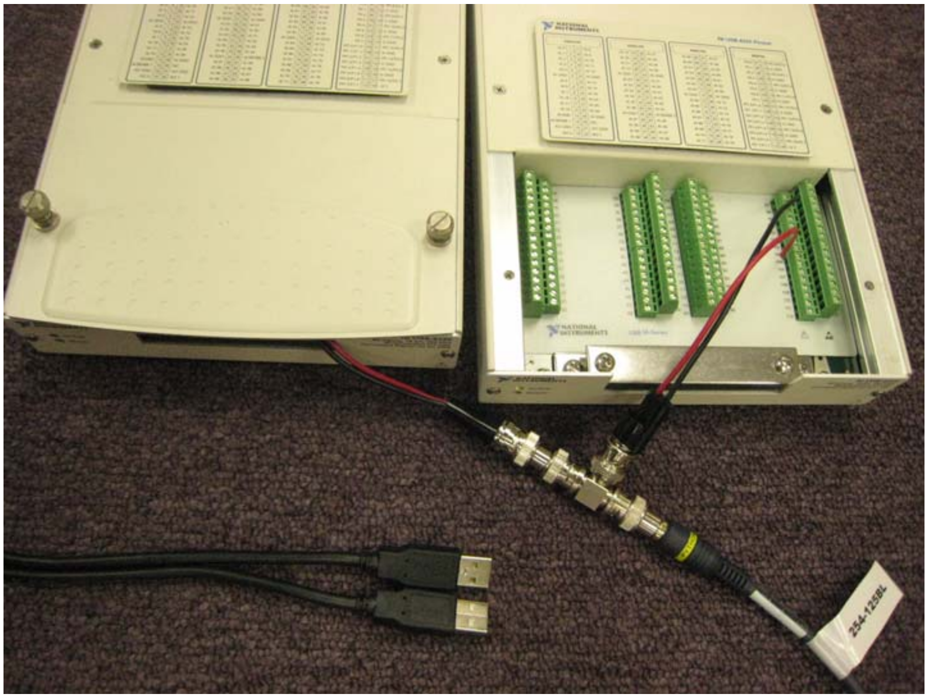
Name	Value
Serial Number	0xE5AE4A

NI-DAQmx Device Basics

What do you want to do?

Installing the Clock Wiring from the Master Camera

Figure B-3. Clock Wiring



- Master Camera Red (or white): Connects to Pin 1 (PFI0)
- Master Camera Black: Connects to Pin 11 (D GND)
- 4.7 kΩ Resistor connects from Pin 1 (PFI0) to Pin 10 (+5 V)

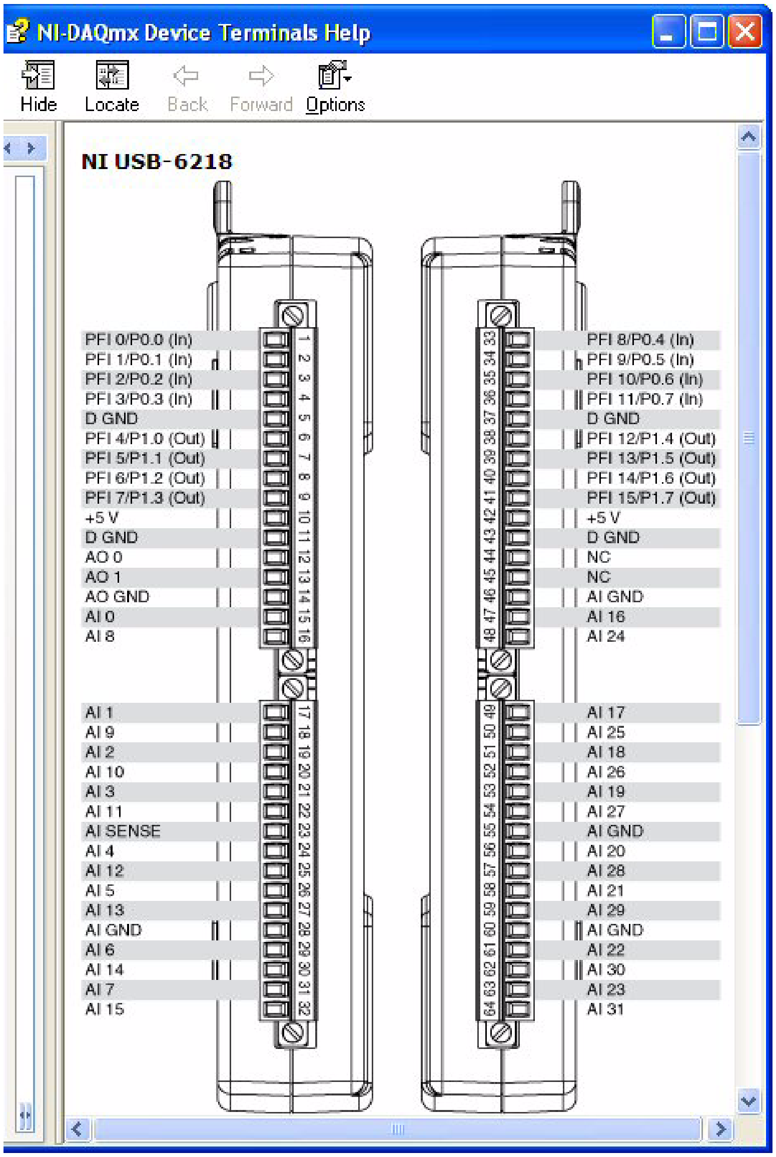
Note: A jumper cable is required if multiple NI 6218 units are being used together (> 32 channels).

Note: NI USB-6259 uses PFI7 for clocking.

NI USB-6259 Analog Input Connections are listed in Table B-3 on page B-12.

Note: A 4.7 kΩ pull-up resistor is not needed on camera systems where a Raptor camera or a Hawk-m camera is set as the Master camera.

Figure B-4. NI USB-6218 Pinouts



Pin	Signal	Pin	Signal
1	PFI 0/P0.0 (In)	33	PFI 8/P0.4 (In)
2	PFI 1/P0.1 (In)	34	PFI 9/P0.5 (In)
3	PFI 2/P0.2 (In)	35	PFI 10/P0.6 (In)
4	PFI 3/P0.3 (In)	36	PFI 11/P0.7 (In)
5	D GND	37	D GND
6	PFI 4/P1.0 (Out)	38	PFI 12/P1.4 (Out)
7	PFI 5/P1.1 (Out)	39	PFI 13/P1.5 (Out)
8	PFI 6/P1.2 (Out)	40	PFI 14/P1.6 (Out)
9	PFI 7/P1.3 (Out)	41	PFI 15/P1.7 (Out)
10	+5 V	42	+5 V
11	D GND	43	D GND
12	AO 0	44	NC
13	AO 1	45	NC
14	AO GND	46	AI GND
15	AI 0	47	AI 16
16	AI 8	48	AI 24
17	AI 1	49	AI 17
18	AI 9	50	AI 25
19	AI 2	51	AI 18
20	AI 10	52	AI 26
21	AI 3	53	AI 19
22	AI 11	54	AI 27
23	AI SENSE	55	AI GND
24	AI 4	56	AI 20
25	AI 12	57	AI 28
26	AI 5	58	AI 21
27	AI 13	59	AI 29
28	AI GND	60	AI GND
29	AI 6	61	AI 22
30	AI 14	62	AI 30
31	AI 7	63	AI 23
32	AI 15	64	AI 31

The USB device pinouts are available online after you install the device. To find them:

1. Launch **Measurement & Automation** which was installed when you installed the NIDAQ software.
2. Select **Devices and Interfaces**, then **NI-DAQmx Devices** and the page should appear as shown above.

Note: NI Numbering starts at Channel 0 where **Cortex** channel numbering starts at 1. For example: AI 0 (above) corresponds to **Cortex** Channel 1.

Which USB Device is Channels 1-32, which is 33-64?

The first device you plug in should be channels 1-32 in your **Cortex** software. The second device should be channels 33-64 and so on for more devices. If you are not sure: When you connect to the Cameras in **Cortex**, the channel numbers (1-32) and the Serial Number of the USB device are reported in the dialog box. The Serial Number for the USB-6218 device is located on the bottom of the USB device.

Clock Wiring for Single and Multiple USB Devices

For Eagle, Eagle4, and Hawk cameras, the system will require a 4.7 kΩ pull-up resistor from +5 Volts to the PFI-0 pin as shown in Figure B-3 on page B-7.

A Single Pull-up resistor with a 4.7 kΩ (or close) value will work for connecting up to 6 USB devices together as shown below. You need only to connect PFI0 and D GND signals in parallel for clocking the multiple USB Devices. A single pull-up resistor works for all devices.

Note: A 4.7 kΩ pull-up resistor is not needed on camera systems where a Raptor camera or a Hawk-m camera is set as the Master camera.

USB 2.0 Cable Lengths

The USB-6218 comes with a USB cable. It has been tested with longer USB cable lengths up to 16 ft. (5 meters) and it works well with any mix of cables.

USB Expansion Ports for Multiple A/D Units

Internal or External USB Expansion devices also have been tested and work well without problems. This allows you use a single USB port on the main capture computer and plug in as many USB devices as needed. It is recommended that a powered USB expansion port is used for multiple NI USB devices.

Table B-2. Analog Input Channel Connections and Master Camera Clocking (NI USB-6218)

Screw Terminal #	Cortex Channel #	Setup Name	Screw Terminal #	Cortex Channel #	Setup Name
1	PFI 0	**4.7 kΩ Resistor & A/D Sync Cable & Jumper Cable***	33	PFI 8	Not Used
2	PFI 1	Not Used	34	PFI 9	Not Used
3	PFI 2	Not Used	35	PFI 10	Not Used
4	PFI 3	Not Used	36	PFI 11	Not Used
5	D GND	Not Used	37	D GND	Not Used
6	PFI 4	Not Used	38	PFI 12	Not Used
7	PFI 5	Not Used	39	PFI 13	Not Used
8	PFI 6	Not Used	40	PFI 14	Not Used
9	PFI 7	Not Used	41	PFI 15	Not Used
10	+5 V	**4.7 kΩ Resistor**	42	+5 V	Not Used
11	D GND	**A/D Sync Ground & Jumper Cable***	43	D GND	Not Used
12	AO 0	Not Used	44	NC	Not Used
13	AO 1	Not Used	45	NC	Not Used
14	AO GND	Not Used	46	AI GND	Not Used
15	CH 1		47	CH 17	
16	CH 9		48	CH 25	
17	CH 2		49	CH 18	
18	CH 10		50	CH 26	
19	CH 3		51	CH 19	
20	CH 11		52	CH 27	
21	CH 4		53	CH 20	
22	CH 12		54	CH 28	
23	AI SENSE	Not Used	55	AI GND	Not Used
24	CH 5		56	CH 21	
25	CH 13		57	CH 29	
26	CH 6		58	CH 22	
27	CH 14		59	CH 30	
28	AI GND	Not Used	60	AI GND	Not Used
29	CH 7		61	CH 23	
30	CH 15		62	CH 31	
31	CH 8		63	CH 24	
32	CH 16		64	CH 32	

Note:* A Jumper Cable is required if multiple NI USB-6218 units are being used together (> 32 channels).

Note: NI Numbering starts at Channel 0 where **Cortex** channel numbering starts at 1. For example: AI 0 corresponds to **Cortex** Channel 1.

Maximum Analog Acquisition Rate

When measuring 64 or more channels with 16-bit resolution, the maximum analog rate is determined by one of the following considerations:

1. The maximum throughput of the National Instruments (NI) A-D product
2. The video sample rate multiplied by 255

The NI USB-6218 A-D unit, which is often supplied with Motion Analysis systems, has a maximum throughput of 250,000 samples/sec (per unit). So two units with 64 channels would have the ability to collect up to 500,000 samples/sec. Either way, it is 250,000/32 channels or about 7500 samples/sec per channel with all channels collecting data. If you cut down to 16 channels, you can have 15,000 samples/sec per channel. You can also connect up to 6 devices and use only 16 channels from each device.

For increased speed, use the faster USB-6259 A-D unit from NI. This unit is 32 channels, 16 bits (same as USB-6218), but has a throughput of 1.25 Million samples/sec or 5-times greater than the throughput of the USB-6218.

The video sample rate multiplied by 255 limitation comes into play mainly if a slow mocap video rate (e.g. 60 Hz) is being used. The max analog rate in this case is 15,300 (60 X 255). Under normal conditions, customers using higher analog rates would also be using higher mocap video rates. With a mocap video rate of 200 Hz, the max analog setting is 200 multiplied by 255 or 51,000 Hz. Note that you can do this with the USB-6218 with fewer channels turned on: 250,000/ 51,000 = 4.9 (or 4 channels).

NI USB-6259 Analog Channel Connections

The following table (Table B-3) provides the analog channel connections and master camera clocking for the NI USB-6259 as interfaced in the **Cortex** software.

Table B-3. Analog Input Channel Connections and Master Camera Clocking (NI USB-6259)

Screw Terminal #	Cortex Channel #	Setup Name	Screw Terminal #	Cortex Channel #	Setup Name
1	CH 1		49	CH 21	
2	CH 9		50	CH 29	
3	AI GND		51	AI GND	
4	CH 2		52	CH 22	
5	CH 10		53	CH 30	
6	AI GND		54	AI GND	
7	CH 3		55	CH 23	
8	CH 11		56	CH 31	
9	AI GND		57	AI GND	
10	CH 4		58	CH 24	
11	CH 12		59	CH 32	
12	AI GND		60	AI GND	
13	NOT USED		61	NOT USED	
14	AI GROUND		62	AI GND	
15	NOT USED		63	NOT USED	
16	NOT USED		64	NOT USED	
17	CH 5		65	NOT USED	
18	CH 13		66	NOT USED	
19	AI GND		67	NOT USED	
20	CH 6		68	NOT USED	
21	CH 14		69	NOT USED	
22	AI GND		70	NOT USED	
23	CH 7		71	NOT USED	
24	CH 15		72	NOT USED	
25	AI GND		73	PFI 0	
26	CH 8		74	PFI 1	
27	CH 16		75	PFI 2	
28	NOT USED		76	PFI 3	
29	NOT USED		77	PFI 4	
30	AI GND		78	PFI 5	
31	NOT USED		79	PFI 6	
32	NOT USED		80	PFI 7	4.7 kΩ Resistor & A/D Sync Cable & Jumper Cable*
33	CH 17		81	PFI 8	
34	CH 25		82	D GND	
35	AI GND		83	PFI 9	
36	CH 18		84	D GND	
37	CH 26		85	PFI 10	
38	AI GND		86	D GND	
39	CH 19		87	PFI 11	
40	CH 27		88	D GND	
41	AI GND		89	PFI 12	
42	CH 20		90	D GND	A/D Sync Ground & Jumper Cable*
43	CH 28		91	PFI 13	
44	AI GND		92	D GND	
45	NOT USED		93	PFI 14	
46	AI GND		94	D GND	
47	NOT USED		95	PFI 15	
48	AI GND		96	+5 V	4.7 kΩ Resistor

* A Jumper Cable is required if multiple NI USB 6259 units are being used together (> 64 channels)

Appendix C

Force Plate Configuration

(Forceplate.cal File Setup)

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General Information

Forceplate setup information is saved in your Setup (.cal) file and can be configured from the **Tools > Forceplate Configuration** menu.

Up to eight force plates may be placed within the video capture space to measure gait forces. While **Cortex** gathers video data, it simultaneously acquires force plate data and calculates forces calibrated in Newtons or other force units.

In earlier EVaRT systems (and in OrthoTrak), the software used the forcepla.cal file for calibration and configuration. In Cortex, the force plate calibration and configuration is saved in the Setup (.cal) file. The (legacy) forcepla.cal file can be imported or exported from the **Tools > Forceplate Configuration** menu.

The **forcepla.cal** file contains information describing the location, orientation, and calibration of each force plate used. The exact form of the file will depend on the force plate manufacturer. Figure C-1 shows the file form for Bertec and AMTI force plates. Figure C-2 shows the file form for Kistler force plates.

The **forcepla.cal** file contains no text, only numbers. For multiple force plates, the data for each force plate in the system is included in one **forcepla.cal** file (see Figure C-4).

Note: The **forcepla.cal** file must be in the same directory as either the **Cortex.exe** file or the ***.prj** file. Otherwise, the force plate outlines will not appear in the 3D collection view.

Note: **Forcepla.cal** files in the past have been named with a “t”, as force plate. Be sure to check that there is no “t” in **forcepla.cal**.

Example **Forcepla.cal** files for each type of force plate (AMTI, Bertec, and Kistler) can be found in the directory: **C:\Program Files\Motion Analysis\Cortex2\Samples\Example Forceplate Configurations.**

Figure C-1. Forcepla.cal File Structure for Bertec and AMTI Force Plates

Line#	**Description**
1	**Force plate number (1 through 8)**
2	**Force plate scaling factor and [optional length and width of force plate] (25 for AMTI setup with amplifier gain switches set to 4000)**
3	6x6 force plate calibration matrix (Inverted Sensitivity) provided by the manufacturer
4	
5	
6	
7	
8	
9	**Xo Yo Zo True XYZ origin relative to the geometric center of the force plate—in cm (provided by the manufacturer).**
10	**Xc Yc Zc XYZ location of the geometric center of the plate with respect to your video coordinate system. (the video calibration system’s origin)—measured in cm**
11	3x3 force plate orientation matrix to make the force plate coordinate system match the laboratory coordinate system
12	
13	

Figure C-2. Forcepla.cal File Structure For Kistler Force Plates.

Line#	**Description**
1	**Force plate number followed by “K” to indicate a Kistler force plate.**
2	**Force plate scaling factor and [optional length and width of force plate]**
3	8x8 force plate calibration matrix created by the user
4	
5	
6	
7	
8	
9	
10	
11	**Xo Yo Zo position of the force plate transducers in cm (provided by the manufacturer)**
12	**Xc Yc Zc XYZ location of the geometric center of the plate with respect to your video coordinate system. (the video calibration system’s origin)—measured in cm**
13	3x3 force plate orientation matrix to make the force plate coordinate system match the laboratory coordinate system
14	
15	

Force Plate File Data

Force Plate Number

A unique number is assigned to each force plate in the system.

Force Plate Scaling Factor and Optional Length & Width

The scaling factor depends on the force plate manufacturer and the gain setting. Length and width are optional and are measured in cm. Length and width orientation is also dependent on the force plate manufacturer. Refer to later sections specific to the manufacturer of your force plate.

Force Plate Calibration Matrix

The calibration matrix transforms the output of the force plate into forces and moments. Refer to the section later in this appendix specific to the manufacturer of your force plate.

True XYZ Origin

This is the offset of the origin of the force plate XYZ coordinate system relative to the center of the top surface of the force plate. Each manufacturer provides this offset value.

XYZ Location in Video Coordinate System

This tells the **Cortex** system where the center of the top surface of the force plate is located relative to the **Cortex** video coordinate system. Once this is established, the video calibration frame must be placed in the same location each time you calibrate. The center of the top surface can be found by measurement or drawing diagonal lines from opposite corners. The units of measurement are centimeters (cm).

3x3 Orientation Matrix

This matrix describes the orientation of the force plate relative to the laboratory or room coordinate system. It is a matrix of direction cosines of the angles between the force plate coordinate system and the laboratory coordinate system. Using the terminology cos(Xplate, Xlab) to indicate the angle between the force plate X axis and the laboratory X axis, the matrix takes the following form:

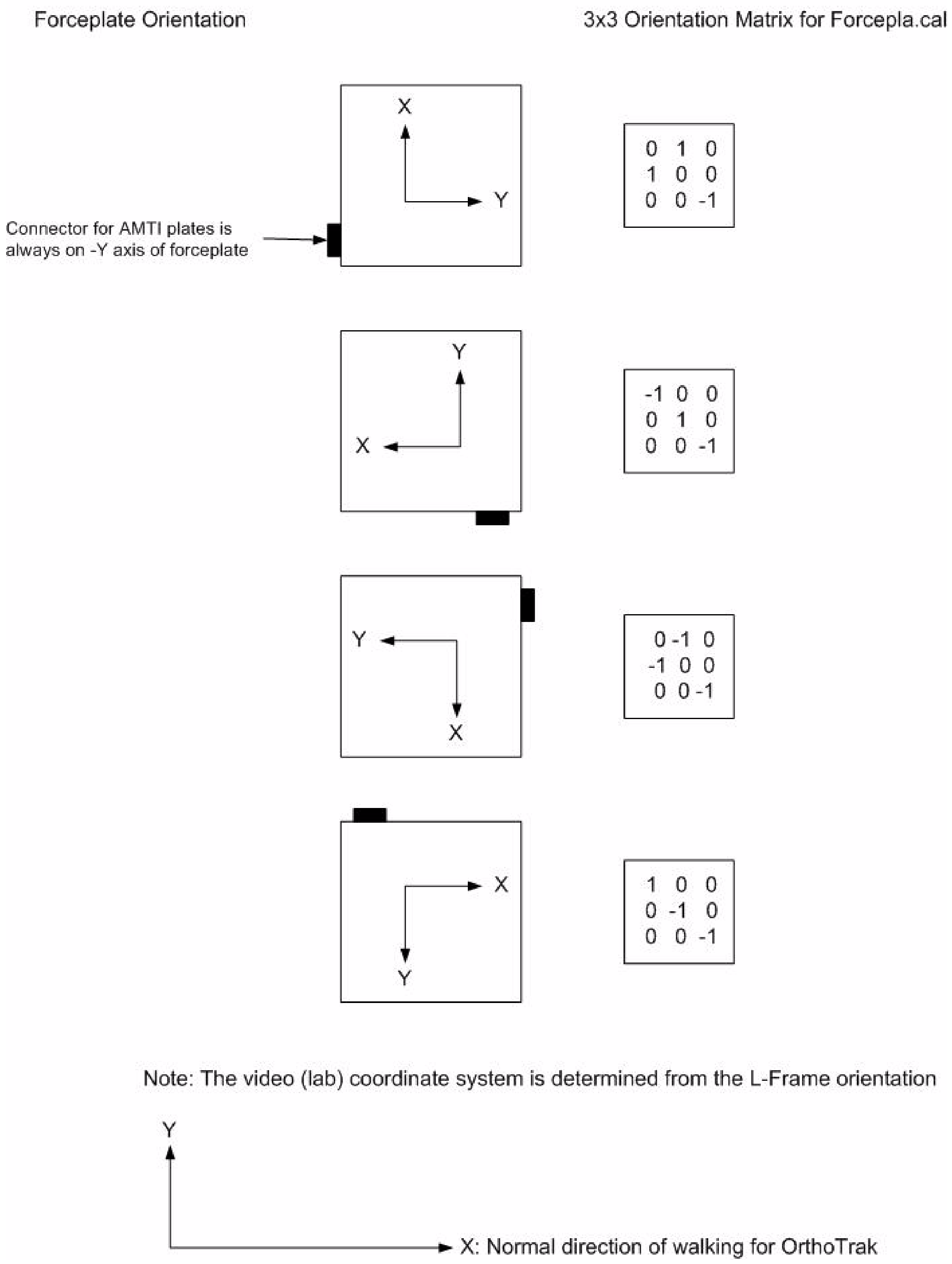
	Xplate	**Y**plate	**Z**plate
Xlab	cos(**X**plate, **X**lab)	cos(**Y**plate,**X**lab)	cos(**Z**plate,**X**lab)
Ylab	cos(**X**plate, **Y**lab)	cos(**Y**plate,**Y**lab)	cos(**Z**plate,**Y**lab)
Zlab	cos(**X**plate, **Z**lab)	cos(**Y**plate,**Z**lab)	cos(**Z**plate,**Z**lab)

Since, in real situations, the force plate should be aligned with the room coordinate system, the numbers in this matrix will always have one of three values:

Angle = 0 cos = 1
Angle = 90 cos = 0
Angle = 180 cos = –1

Example matrices are shown in the following figure:

Figure C-3. Force Plate Coordinates System


Forceplate Orientation
3x3 Orientation Matrix for Forcepla.cal
X
Y
Connector for AMTI plates is always on -Y axis of forceplate
0 1 0
1 0 0
0 0 -1
Y
X
-1 0 0
0 1 0
0 0 -1
Y
X
0 -1 0
-1 0 0
0 0 -1
X
Y
1 0 0
0 -1 0
0 0 -1
Note: The video (lab) coordinate system is determined from the L-Frame orientation
Y
X: Normal direction of walking for OrthoTrak

Force Plate Scaling Factor, X-Width and Y-Length

The scaling factor depends on the force plate manufacturer, and the force plate amplifier gain setting and the voltage range.

Table C-1. Sample Force Plate Scaling Factors

Force Plate Manufacturer	Scaling Factor
AMTI	For Gain 4000—Use 25.0
Bertec	Use 0.25 if using AM6501 Analog Unit (output ±5V)
Kistler	±10 Volt Amplifier—Use 1.0 ±5 Volt Amplifier—Use 0.5

The x-width and y-length are the force plate measurements in centimeters as measured in the force plate coordinate system. Check the manufacturer's specifications. If no x-width and y-length values are used, AMTI and Bertec force plates default to 18-inches by 20-inches, and Kistler force plates default to 50-centimeters by 50-centimeters.

Using AMTI and Bertec Force Plates

AMTI Gain Setting

For the AMTI force plates, a gain of 4000 mV and a cutoff frequency of 1050 kHz is recommended. Using the method outlined in the AMTI literature, this gain yields a scaling factor for the **forcepla.cal** file of 25. The example in Figure C-4 uses an AMTI force plate.

Bertec Gain Setting

A gain setting of 10 for Bertec force plates is recommended. In the **forcepla.cal** file you should set *scaling factor = (1 / gain)/2*, yielding a **scaling factor** of 0.25 (for a gain setting of 2). If using the AM6501 analog out device, the gain is preset and the analog voltage range should be ±5V.

The Calibration Matrix

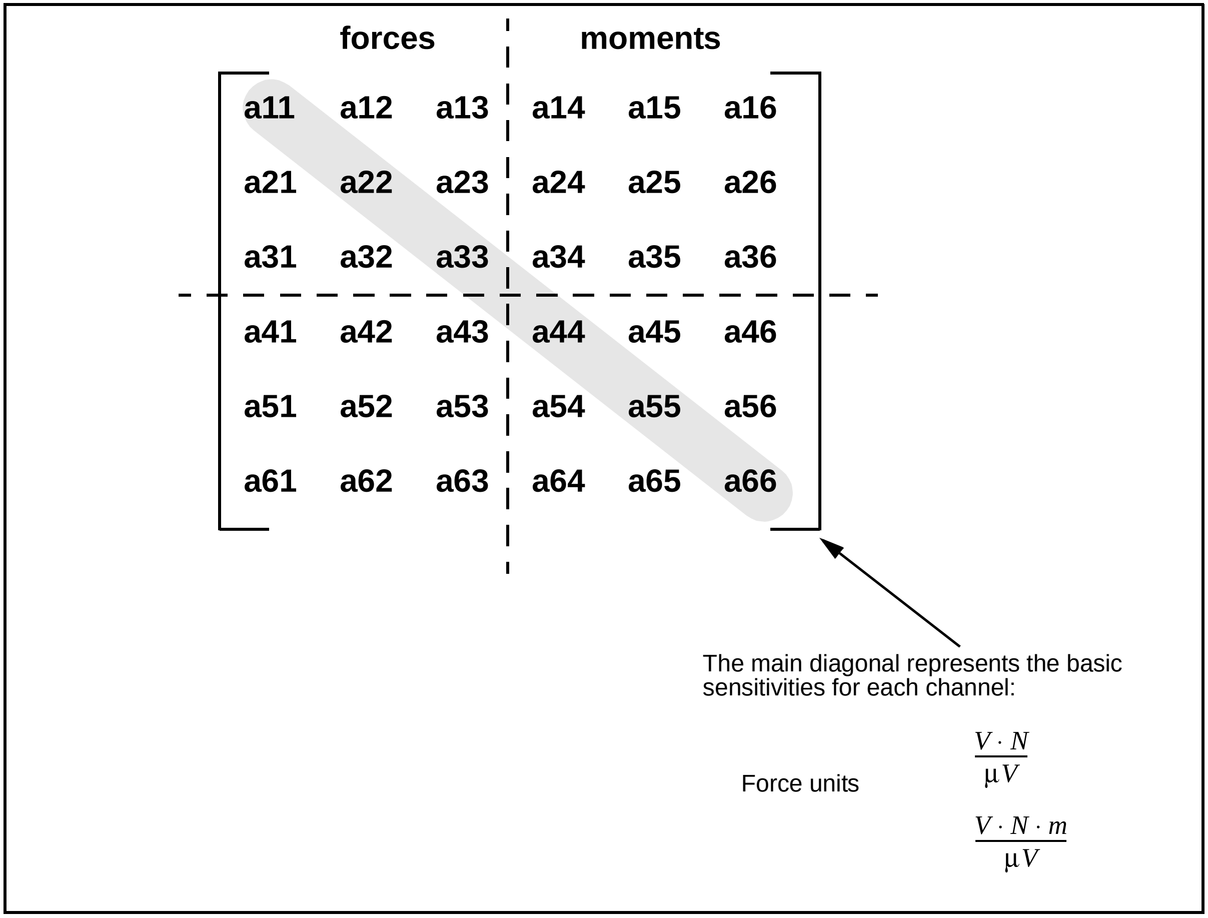
The 6x6 calibration matrix (Inverted Sensitivity) is provided by the manufacturer (AMTI). It is used to transform the output of the force-plate into three force vectors and three moment vectors. The form of the matrix is shown in Figure E-5. The main diagonal of the matrix (upper left to lower right) represents the basic channel sensitivities. The off diagonal terms represent the channel cross-talk.

If using Bertec plates with the AM6501, the amplifier is built into the plate and outputs data using a 15-pin D-Sub-connector cable to a small interface unit with signals in the range ±5V. In this case the amplifier is pre-calibrated, internally, with no off-axis elements in the 6x6 matrix. There are pre-defined and fixed values for the diagonal axis values. These can be exactly the same for each plate but check the Bertec documentation for the values appropriate to your plate. See the sample forcepla.cal file (Figure C-4). If using other Bertec hardware (e.g. AM6504 or AM6800), please check the output range and scale factors with the manufacturer.

Figure C-4. Example Forcepla.cal File for 2 Force Plates

```
1.
25  51  46.5
2.9350    0.0040    0.0130    –0.0480   –0.0400   0.0050
–0.0020   2.9930    0.0470    0.0080    –0.0250   0.0410
–0.0270   0.0120    11.5420   –0.0240   0.0030    0.0160
0.0000    –0.0070   0.0000    1.5390    –0.0110   0.0010
–0.0070   –0.0020   0.0000    0.0000    1.5350    –0.0040
0.0020    0.0020    –0.0050   0.0020    –0.0040   0.7440
–0.1000   –0.0260   –3.8000
5.6000    –25.7000  –4.2000
0.0000    1.0000    0.0000
1.0000    0.0000    0.0000
0.0000    0.0000    –1.0000
2.
25  51  46.5
2.9340    0.0090    0.0020    –0.0130   0.0170    0.0110
0.0120    2.9750    0.0450    0.0310    –0.0200   0.0340
0.0050    0.0020    11.5480   –0.0210   –0.0090   0.0070
–0.0040   0.0010    0.0000    1.5470    –0.0020   –0.0030
0.0010    –0.0020   0.0000    0.0020    1.5450    –0.0080
0.0020    0.0060    0.0000    0.0010    –0.0060   0.7480
–0.1000   0.0300    –4.2000
56.5      –25.7000  –4.2000
0.0000    –1.0000   0.0000
–1.0000   0.0000    0.0000
0.0000    0.0000    –1.0000
```

Figure C-5. The 6x6 Calibration Matrix



$$\begin{array}{c|c} \text{forces} & \text{moments} \\ \left[\begin{array}{ccc} a11 & a12 & a13 \\ a21 & a22 & a23 \\ a31 & a32 & a33 \\ \hline a41 & a42 & a43 \\ a51 & a52 & a53 \\ a61 & a62 & a63 \end{array}\right. & \left.\begin{array}{ccc} a14 & a15 & a16 \\ a24 & a25 & a26 \\ a34 & a35 & a36 \\ \hline a44 & a45 & a46 \\ a54 & a55 & a56 \\ a64 & a65 & a66 \end{array}\right] \end{array}$$

The main diagonal represents the basic sensitivities for each channel:

Force units $\frac{V \cdot N}{\mu V}$

$\frac{V \cdot N \cdot m}{\mu V}$

The information provided by the manufacturer may include only the basic sensitivities for each channel with no values for cross-talk. In this case, the matrix should be filled with the basic sensitivities on the main diagonal and zeroes elsewhere.

Also notice that the upper right quadrant of the matrix contains the force sensitivities and the lower right contains the moment sensitivities. In every case, the force sensitivities are greater than the moment sensitivities. **Cortex** uses this information to switch matrix quadrants (permute the matrix) if the manufacturer should supply the matrix with the moments on the left and force on the right.

Note: The calibration matrix is intended to be used with your plate’s coordinate system, not the room’s. For this reason, if your plate is not aligned with the room, correct it with the 3x3 orientation matrix, not by switching wires or A/D signal names.

Using Kistler Force Plates

Signal Names

The Kistler force plate has 8 outputs. Therefore, two force plates will use 16 channels on the A/D card. The signal naming conventions are shown in Figure C-6. The names in the analog ANB (or ANA) file must appear exactly as shown in the **Cortex** ANB (or ANA) column.

Gain Setting

With the Kistler force plate, the Charge Amplifier (model 9865) should be set on **range #3** for the X/Y and Z range settings (X and Y are set together). This is the 10,000 pC setting.

This setting can be changed if desired, but the **forcepla.cal** file will have to reflect the change. A **gain = 1** on the A/D board should be used since the Kistler outputs 10 V full scale.

Calibration Matrix

The Kistler force plate requires an 8x8 calibration matrix. The matrix only contains non-zero data on the main diagonal (upper left to bottom right). All non-diagonal cross-talk elements are zero.

To calculate the values to use on the main diagonal of the matrix (assuming nominal sensitivity values of 7.8 and 3.8 pC/N):

X and Y Scaling	(10000 pC / 7.8 pC/N) / 10 V = 128.2 N/V
Z Scaling	(10000 pC / 3.8 pC/N) / 10 V = 263.4 N/V

Figure C-6 shows an example 8x8 matrix in a **forcepla.cal** file.

True XYZ Origin

This is a measure of the X, Y, and Z distances to the piezoelectric transducers used to generate the signals in the Kistler force plates. These numbers are supplied by the manufacturer.

Figure C-6. Example Forcepla.cal File For a Kistler Force Plate

```
1K
1.0
128.2     0         0         0         0         0         0         0
0         128.2     0         0         0         0         0         0
0         0         128.2     0         0         0         0         0
0         0         0         128.2     0         0         0         0
0         0         0         0         263.4     0         0         0
0         0         0         0         0         263.4     0         0
0         0         0         0         0         0         263.4     0
0         0         0         0         0         0         0         263.4
12.000    20.000    –5.4000
0.0       0.0       0.0
1         0         0
0         –1        0
0         0         –1
```

General Notes On Kistler Force Plates

1. Since the Kistler force plate format is flagged with a “K” after the force plate number, Kistler and other force plates may be included in a single system.
2. The proper way to orient the force plate is the 3x3 orientation matrix, not the calibration matrix.

Note: Do not switch the cables to the A/D board.

3. Keep the Long Term Constant turned off on the charge amplifier.
4. Reset the charge amplifier before each test, or at least every few tests. This re-establishes the zero for the charge amplifier.

Notes

- The forcepla.cal file is unable to distinguish between AMTI, Bertec and Tec Gihan. As such, if you export any of these plate types to a forcepla.cal file and re-import them, they will be imported as AMTI plates.
- AMTI, Bertec and Tec Gihan all use the same analog channel naming convention.

Appendix D

SDK—Software Developers Kit

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SDK Overview

The SDK is available for the advanced user who wishes to incorporate the output data stream from **Cortex** into a software application.

The Software Developers Kit, which provides the tools for interfacing your program with **Cortex** is available by special request from Motion Analysis Corp. at Support@MotionAnalysis.com.

SDK Programming Example: Write your own Streaming Plugin

There is a Software Development Kit (SDK) which is written in the Visual C/Visual C++ language and an example C program that is available at no charge that demonstrates how to use the SDK. This allows our customers to use this as a starting point and creating their own program.

The sample program shows you how to connect to the **Cortex** software and request that the kind of data that you want be transferred (Marker XYZ data and/or Skeleton HTR data). The sample C program then writes out the data to a disk file. Please also note that the data can be streamed either from the live camera data (that is happening in real time), or from the Post Processing software when you press the Play button. The data is the same either way and the SDK program does not even need to know since it comes across the same way. So, the customer can write the program from previously edited XYZ data in the Post Processing part of **Cortex** and get that to working. Press the **Play** button, you see the edited tracks and the data is streamed to the SDK. Then they can connect to the cameras and get the same XYZ or HTR type data from the live cameras.

Appendix E

Import and Export File Formats

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Binary Files—ANB, TRB, and C3D	E-14

Overview

The files generated by **Cortex** fall into two main categories: ASCII and binary. ASCII files contain data in a text form that can be read by any text editor. They usually have descriptive headers that indicate the nature of the data that follows. Often these files are in a row and column format that allows data to be read and manipulated by spreadsheet programs such as **Excel**^{TM}. ASCII files are not compact and can be quite large.

Binary files contain raw binary data and are more compact than ASCII files. They cannot be read by a text editor. In general, binary files are not meant to be read by the end user.

mac_lic.dat

All Motion Analysis software requires a valid license to run. The license is keyed to a particular dongle supplied by Motion Analysis, which can be tranferred from one computer to another.

The license file is ASCII and has the unique name **mac_lic.dat**. It is located in the **Motion Analysis** directory. Only one license file is used for all Motion Analysis software. Each additional software application beyond **Cortex** is given a separate line in the license file, with the license type enclosed in square brackets **[ ]** followed by two license codes.

If you acquire new Motion Analysis software, you must use a text editor to enter the new line in your license file to enable your new software. This line can be typed in or entered by cutting it from the file you receive and pasting it into the existing license file. The order of the licenses in the file is not important and only those lines that start with a **[** (left bracket) are read by the software.

Note: Make sure that file extensions are not hidden, which is the default. This makes the **mac_lic.dat** look like **mac_lic,** which might be renamed to **mac_lic.dat.dat**. If this happens, the system will not recognize the license file.

Figure E-1. An Example of a Motion Analysis License File

```
Motion Analysis License File
Customer: MAC Customer
Platform: NT
SystemID: 19c
Created: 9/15/20xx 1:42:26 PM
Sales Order#: 05-xxx
Entered By: Support
[Cortex 2.0] aed50167    873b2d56
[Analog Input]       b9806c31    d1567841
[OrthoTrak]          b2df5e69    8964274a
[Animation Plugins]  b1a46160    805b5c49
[Director/Sequencer] e1a04e65    85745819
[RT2 Animation Plugins] e3f05340    a069081b
[Analog Input]       b9806c31    d1567841
[Calcium 4]          e7ed5923    c363151f
[Skeleton Builder 4] a3f44279    99780c5b
[Reference Video 3.0] eb92592f    cf636a13
[Talon Streaming 4]  ecb36136    d65b4b14
[Talon Viewer 4]     86fb0714    f43d037e
[Motion Composer]    c7f00e25    c534083f
This license has no expiration.
```

PRJ—Legacy Cortex Project File

For earlier versions of Cortex (prior to Cortex 2), every motion capture session uses a project file containing all system settings, equipment parameters, and other information related to the project. This file contains both equipment parameters common to many different setups and calibration values unique to one particular session. Among the data found in a project file are:

- the system setup
- the marker set
- calibration setup and results
- linkages between markers
- SkB segment definitions, coordinate systems, and hierarchies
- (optional) MoCap Solver segment definitions, joint types, and hierarchies
- camera type and parameters

In most cases, you will begin a session by loading an existing project file, editing it as necessary, and saving it in the directory where the motion data is to be saved. Any time you calibrate the system or edit project parameters, you should save the project file to disk to retain the new information.

Important

Project files contain ASCII data and it may be useful to view them using any text editor, however, you should never edit them in a text editor.

TRC—Track Row Column

The **.trc** file contains X-Y-Z position data for the reflective markers. This is an ASCII file in a Row/Column, horizontal tab delimited format that can be easily read into a spreadsheet program such as **Excel**™ and **Lotus**™. The position data for each marker is organized into 3 columns per marker (X, Y and Z position) with each row being a new frame. The position data is relative to the global coordinate system of the capture volume and the position values are in the units used for calibration.

The file is made up of three parts:

- the file header,
- the position data header, and
- the position data.

All fields in this file type are separated by horizontal tabs.

File Header

The **.trc** file header occurs on the first three rows.

- Row one contains the path file type label (string), path file type number (int), path file type descriptor (string) and original directory path and file name (string).

- Row two contains the data rate label (string), the camera rate label (string), the number of frames label (string) and the units label (string).
- Row three contains the data rate value (real), the camera rate value (real), the number of frames (int) and data units (string).

Data Header

The data header occupies rows four and five.

- Row four contains the frame number label (string), the time label (string) and followed by the marker name labels (string). There are three horizontal tab characters between each marker name label. These names usually correspond to the location where a reflective marker was placed on the subject.
- Row five contains the column labels (string) for the position data starting on row six. For each marker name there is an X, Y and Z column. These axes labels have the trajectory numbers appended to them.

Position Data

Position data begins at row six. Column one of the data fields contain the frame number (int). Column two contains the time (real) and columns from three on contain the X, Y and Z position data (real) for each trajectory. There are three columns for every trajectory.

Empty Fields

An empty frame of position data (missing data) is represented as three consecutive horizontal tab characters.

Example

Shown below is a portion of a file with the following attributes:

- captured rate = 60 frames per second
- total frames = 90
- total reflective markers = 33
- units of measure = mm

Data for only the first 3 markers is shown, the remaining markers would appear in columns to the right. Also, data for only the first 12 frames is shown, the remainder would appear in rows below frame 12.

Figure E-2. An Example of a TRC File

```
PathFileType4 (X/Y/Z)         /usr/people/evademo/Oct14/MichelleInit1.trc
DataRate  CameraRate           NumFrames          NumMarkers               UnitsOrigDataRate
.60.0           60.0                  90                  33                  mm      60.0
Frame#Time  Head_Top                         LHead                         RHead                          . .
                  X1        Y1        Z1        X2        Y2        Z2        X3        Y3        Z3      . .
1    0.000  234.5437 1673.7619  232.2308  316.7533 1608.3785  218.5500  144.7963 1597.3691  274.4994      . .
2    0.017  235.2399 1673.4542  232.1284  316.6074 1608.2884  219.0597  144.7684 1597.8106  274.2137      . .
3    0.033  235.2361 1673.4926  232.1852  316.1265 1608.1984  219.7480  144.7296 1597.8043  274.3916      . .
4    0.050  235.0781 1673.4376  232.2152  316.5659 1607.9659  219.6344  144.7652 1597.5711  274.4420      . .
5    0.067  235.0781 1673.4376  232.2152  316.7533 1608.3785  218.5500  144.7296 1597.8043  274.3916      . .
6    0.083  235.0781 1673.4376  232.2152  316.2800 1608.3460  219.1676  144.7963 1597.3691  274.4994      . .
7    0.100  235.3844 1673.4179  232.3085  316.4539 1608.1409  219.6402  144.7963 1597.3691  274.4994      . .
8    0.117  235.1416 1673.4447  232.4143  316.4539 1608.1409  219.6402  145.1222 1597.3621  274.3569      . .
9    0.133  235.4312 1673.4882  232.7111  316.1265 1608.1984  219.7480  144.7963 1597.3691  274.4994      . .
10   0.150  236.0334 1673.4269  233.0335  315.9777 1608.3370  220.0773  144.6867 1597.5786  274.4743      . .
11   0.167  235.7562 1673.7265  233.4352  316.4172 1608.1043  219.9638  144.7963 1597.3691  274.4994      . .
12   0.183  235.5336 1673.4414  233.5973  315.9770 1608.0798  220.2932  144.7963 1597.3691  274.4994      . .
. . .. . .     . . .     . . .     . . .     . . .     . . .     . . .     . . .     . . .     . . .      . .
```

HTR - Heirarchical Translations & Rotations

HTR files provide the same information as HTR2 files, but in a segment oriented method which is less suitable for information streaming. The HTR format cannot created in **Cortex**. This feature will be added to future revisions.

Examples of HTR Files

Information about the structure and motion of hierarchical skeletons is stored in **.htr** files. There are two variations of **.htr** files: version 1 (HTR) and version 2 (HTR2). The skeleton data is identical in both file versions, however, the motion data is presented on a segment basis in version 1 files, while it is on a frame basis in version 2 files. Thus, version 1 files give the position data for all frames for the first segment followed by the position data for all frames for the second segment, etc. HTR Version 1 files are used:

1. to save as HTR in **Cortex** under the Post Skeleton function in the Tools menu
2. for input and output from **Si 2.0**
3. for input and output for many of the animation package software

Example of an HTR Version 1 File

The example of a version 1 file shown in Figure E-3 on page E-8 was generated by Motion Analysis **MoCap Solver** and contains data for the movement of a hierarchical skeleton with one root and 19 child segments. Since the file was generated by **MoCap Solver**, the skeleton has fixed length bones.

The complete file contains data for each of the 20 segments. The position of each segment is recorded for 196 video frames. Such a file is quite large, so we have included an abbreviated version here.

The file begins with a **[Header]** section containing general information, such as the number of segments, the number of frames, the frame rate, and other parameters which apply to all data in the file.

This is followed by the **[SegmentNames&Hierarchy]** section which describes the child-parent relationships of the skeleton. Notice that only the **LowerTorso** segment relates to the GLOBAL coordinate system. All other segments motions are described in relation to a parent segment.

In the **[BasePosition]** section, the location of each segment's origin and rotation are described in the skeleton's base position, using the six available degrees of freedom:

Translation in X	Rotation about X axis
Translation in Y	Rotation about Y axis
Translation in Z	Rotation about Z axis

For the child segments, location and rotation are given in terms of the parent. In this skeleton, the origin of all the children lie on the bone (Y axis) of the parent and, therefore, have only Y values. The seventh column gives the length of the bone segment.

The remaining sections contain motion data for each segment relative to the base position. Each section starts with the segment name followed by position data and the scale factor (SF) for each frame. The first segment, **[LowerTorso]**, is unique because it has six values describing its relation to the global coordinate system. All subsequent segments have only three rotational degrees of freedom. Therefore, if you wished to find the global coordinates of any segment in any frame you would follow these steps:

- Calculate the three rotation values for each segment using the values from the desired frame and the base position for that segment. For the root, also calculate each of the three translation values. Be careful to use the correct rotation order as indicated in the header of the **.htr** file.
- Using the positions and rotation of the root segment as a starting point, calculate the global positions of the origin of the first child's coordinate system in the hierarchy.
- Using this calculated global position, calculate the global position of the origin of the next child's coordinate system.
- Continue until you have reached the desired segment.

In the abbreviated example shown in Figure E-3, only the first and last four frames are shown for the first three segments. In the actual file, all 196 frames for each of the 20 segments would appear. After all the segments, an **[EndOfFile]** section terminates the file.

Figure E-3. An Example of a HTR (Version 1) File

```
[Header]                # Header keywords are followed by a single value
FileType htr            # single word string
DataType HTRS           # Hierarchical translations followed by rotations and Scale
FileVersion 1           # integer
NumSegments   20        # integer
NumFrames   196         # integer
DataFrameRate    30     # integer
EulerRotationOrder XYZ  # one word string
CalibrationUnits mm     # one word string
RotationUnits Degrees   # one word string
GlobalAxisofGravity Y   # character, X or Y or Z
BoneLengthAxis Y
ScaleFactor 1.0000

[SegmentNames&Hierarchy]
#CHILD         PARENT
LowerTorso     GLOBAL
UpperTorso     LowerTorso
LCollarBone    UpperTorso
RCollarBone    UpperTorso
LUpArm         LCollarBone
RUpArm         RCollarBone
LLowArm        LUpArm
RLowArm        RUpArm
LHand          LLowArm
RHand          RLowArm
LPelvis        LowerTorso
RPelvis        LowerTorso
LThigh         LPelvis
RThigh         RPelvis
LLowLeg        LThigh
RLowLeg        RThigh
LFoot          LLowLeg
RFoot          RLowLeg
Neck           UpperTorso
Head           Neck



[BasePosition]

#SegmentName Tx, Ty,    Tz,         Rx,        Ry,       Rz,        BoneLength

LowerTorso238.320832923.726971241.2948288.8069650.0000002.422863 141.720766

UpperTorso0.000000141.7207660.000000-9.396187-0.112582-0.4.226674324.970754

LCollarBone0.000000324.9707540.000000-8.9120410.520925-117.992062155.689602

RCollarBone0.000000324.9707540.000000-7.516124-0.516778118.838556127.553756

LUpArm 0.000000155.6896020.000000  11.284636  -3.556895 24.261557  273.483757

RUpArm 0.000000127.5537560.000000  12.990029  2.960321  -24.250841 285.322188

LLowArm0.000000273.4837570.000000  -15.450962 -0.327390 -5.501311  318.246332

RLowArm0.000000285.3221880.000000  -12.465152 -0.572074 -5.115813  305.910223

LHand  0.000000318.2463320.000000  10.682556  -5.620492 27.438027  85.440039

RHand  0.000000305.9102230.000000  5.730878   2.097665  -20.038204 98.351413

LPelvis0.0000000.000000 0.000000   24.672467  -6.972213 -127.877478122.309825

RPelvis0.0000000.000000 0.000000   39.808415  6.985094  127.739824 133.924520

LThigh 0.000000122.3098250.000000  -12.585726 -15.440180-52.153190388.012318
```

```
#Beginning of Data. Separated by tabs

[LowerTorso]
#Fr    Tx     Ty       Tz         Rx         Ry       Rx        SF
1      1262.497925-15.182068-2245.4418950.5336240.713565-1.0697651.000000
2      1262.534546-15.109411-2245.4282230.5902200.697084-1.1088881.000000
3      1262.367920-15.051557-2245.3151860.5882480.707301-1.1631961.000000
4      1261.811279-15.027791-2245.1335450.6069780.696131-1.3261221.000000
. . . . . . . .
. . . . . . . .
. . . . . . . .
193    -25.763012-11.505680-116.749229-85.78657582.456894-104.4607321.000000
194    -31.705627-12.149048-131.977005-81.80329980.946663-100.7663191.000000
195    -40.086079-12.445135-144.204391-77.85765879.605011-97.4399491.000000
196    -49.986629-12.544500-152.518951-74.27449278.596512-94.2411671.000000

[UpperTorso]
#Fr    Tx     Ty       Tz         Rx         Ry       Rx        SF
1      0.0000000.000000 0.000000   -2.259649  -2.946399 -0.475843  1.000000
2      0.0000000.000000 0.000000   -2.341502  -2.767608 -0.420984  1.000000
3      0.0000000.000000 0.000000   -2.331526  -2.552349 -0.414928  1.000000
4      0.0000000.000000 0.000000   -2.328715  -2.410058 -0.305621  1.000000
. . . . . . . .
. . . . . . . .
. . . . . . . .
193    0.0000000.000000 0.000000   2.688713   -0.354111 4.239368   1.000000
194    0.0000000.000000 0.000000   0.312819   -2.503460 6.899297   1.000000
195    0.0000000.000000 0.000000   -1.617305  -3.427358 9.416446   1.000000
196    0.0000000.000000 0.000000   -2.357207  -3.057341 10.941742  1.000000

[LCollarBone]
#Fr    Tx     Ty       Tz         Rx         Ry       Rx        SF
1      0.0000000.000000 0.000000   2.648904   1.239630  0.547259   1.000000
2      0.0000000.000000 0.000000   2.753487   1.291442  0.549240   1.000000
3      0.0000000.000000 0.000000   2.832925   1.339503  0.493109   1.000000
4      0.0000000.000000 0.000000   2.839463   1.330919  0.571445   1.000000
. . . . . . . .
. . . . . . . .
. . . . . . . . .
193    0.0000000.000000 0.000000   2.837519   0.820427  3.997483   1.000000
```

```
194    0.0000000.000000 0.000000   1.948793   0.402037  3.829116   1.000000

195    0.0000000.000000 0.000000   1.872437   0.383394  3.696403   1.000000

196    0.0000000.000000 0.000000   2.747322   0.820163  3.692526   1.000000


. . . . . . . .

. . . . . . . .

. . . . . . . .

. . . . . . . .



[EndOfFile]
```

ANC—Analog ASCII Row Column

ANC (**.anc**) files contain ASCII analog data in row-column format. The data is derived from ***.anb** analog binary files. These binary ***.anb** files are generated simultaneously with video ***.vc** files if an optional analog input board is used in conjunction with video data capture.

To create an ***.anc** file from an ***.anb** file, from the main menu select **File > Export > Export ANC**. The data in ANC files is raw analog data in ASCII form and can be read and manipulated by a spreadsheet program.

Shown in Figure E-4 is the beginning portion of an ***.anc** file.

Figure E-4. Example of an ANC File

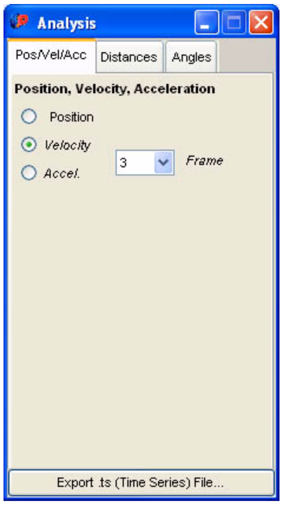
```
File_Type:  Analog R/C ASCII        Generation#:1
Board_Type: National AT-MIO-64F-5   Polarity:Bipolar
Trial_Name:1ndbfw Trial#: 8         Duration(Sec.): 6.000000#Channels:30

Name      f1x    f1y    f1z    m1x    m1y    m1z    f2x    f2y    f2z    m2x    m2y    m2zL tibialis
ant
Rate     1000   1000   1000   1000   1000   1000   1000   1000   1000   1000   1000   1000   1000
Range   10000  10000  10000  10000  10000  10000  10000  10000  10000  10000  10000  10000   2500
0.0000      0      1    -29     -1     -2      0     -1      0    -13      2      3    -11   -550
0.0010     -1      0    -29     -1     -2      0     -2     -1    -13      1      2    -10   -392
0.0020     -1      0    -29     -1     -3      0     -2     -1    -13      1      2    -10   -369
0.0030     -1      0    -29     -2     -3      0     -1     -1    -13      1      2    -10   -440
0.0040      0      0    -29     -1     -2      0     -2     -1    -13      1      3    -10   -342
0.0050      1      1    -29     -1     -2     -1     -2      0    -13      1      3    -11   -531
0.0060      0      0    -29     -1     -2      0     -2     -1    -13      1      3    -11   -803
0.0070      0      0    -28     -1     -2      0     -2     -1    -12      1      3    -10   -738
0.0080      0      0    -28     -1     -2      0     -2     -1    -13      1      2    -10   -485
0.0090      0      1    -28     -1     -2      1      0      0    -12      2      3    -10    453
0.0100      0      0    -28     -1     -2      0     -1      0    -12      2      4    -10    876
0.0110      0      0    -29      0     -2      0     -1     -1    -13      1      3    -10   1401
0.0120      0      1    -29     -1     -2      0     -1     -1    -13      1      2    -10    598
0.0130     -2     -1    -30     -3     -3      0     -3     -3    -13      0      2    -10   -141
0.0140      0      0    -29     -1     -2      0     -2     -1    -13      2      2    -11   -457
0.0150      0      0    -28     -1     -2      0     -2     -1    -13      2      3    -10    446
0.0160      0      0    -29     -1     -2      0     -1     -1    -13      1      2    -11    569
0.0170      0      0    -28     -1     -2      0     -1     -1    -13      1      3    -10    507
0.0180     -1      0    -29     -1     -2      0     -2     -1    -13      2      3    -10    689
0.0190      0      0    -29     -2     -2      0     -2     -2    -12      1      2    -10    501
0.0200     -1      0    -29     -1     -2      0     -2     -1    -13      1      2    -10    348
0.0210     -1      0    -29      0     -2      0     -1     -1    -13      1      3    -11    209
```

TS—Time Series Files from the Cortex Analysis Functions: Velocity and Acceleration Calculations

Cortex Analysis Functions (F7) is a selectable view from the Data Views menu and allows the user to calculate velocity and accelerations of marker data, distances between markers and Included Angles. The Distances and Included angles are assumed to be self-documenting and a description of the Position, Velocity and Acceleration tabs is below. These data can be Exported to the .ts (Time Series) files.

Figure E-5. Analysis Functions


Analysis
Pos/Vel/Acc
Distances
Angles
Position, Velocity, Acceleration
Export .ts (Time Series) File...

○ Position
● Velocity
○ Accel.
3 Frame

There is a Frames Factor, which can be set to 3, 5, 7, or 9 frames. This selects the number of frames to use for the velocity and acceleration calculations. If the Frames Factor is set to 3 frames, velocity data for the 5-th frame is calculated exclusively from frame 4 and frame 6. Velocity Data for frame 1 does not exist; velocity and frame data starts at frame 2. If the Frame Factor is set to 5, the velocity data comes exclusively from –2 frames to +2 frames from the i-th frame. Larger Frame Factors have the effect of smoothing the data.

X1, Y1, Z1 Positional data is determined from the marker locations.

Velocity Calculation is done with a central difference. Let FR represent the Frame Rate of the camera. Time difference between frames = 1 / FR in the below calculations.

Velocity Calculation for frame i with a Frames Factor of 3:

$$vX1(i) = FR^*(X(i+1) - X(i-1)) / 2$$
$$vY1(i) = FR^*(Y(i+1) - Y(i-1)) / 2$$
$$vZ1(i) = FR^*(Z(i+1) - Z(i-1)) / 2$$

Velocity Calculation for frame i with a Frames Factor of 5:

$$vX1(i) = FR^*(X(i+2) - X(i-2)) / 4$$
$$vY1(i) = FR^*(Y(i+2) - Y(i-2)) / 4$$
$$vZ1(i) = FR^*(Z(i+2) - Z(i-2)) / 4$$

Velocity Calculation for frame i with a Frames Factor of 7:

vX1 (i) = FR* (X (i+3) - X (i-3)) / 6
vY1 (i) = FR* (Y (i+3) - Y (i-3)) / 6
vZ1 (i) = FR* (Z (i+3) - Z (i-3)) / 6

Velocity Calculation for frame i with a Frames Factor of 9:

vX1 (i) = FR* (X (i+4) - X (i-4)) / 8
vY1 (i) = FR* (Y (i+4) - Y (i-4)) / 8
vZ1 (i) = FR* (Z (i+4) - Z (i-4)) / 8

Resultant velocity scalar:

vR1 (frame i) = SQRT(vX1**2 + vY1**2 + vZ1**2)

Accelerations for Frame i are calculated as the differences in velocity as:

A (frame i) = Velocity (frame I >frame i+1) - Velocity (frame i-1 >frame i)

Time difference between frames = 1/ FR .

Acceleration Calculations sing the Frame Rate (FR) of the camera for a Frames Factor of 3:

aX1 (i) = FR*FR* (X (i+1) - 2* X(i) + X (i-1))
aY1 (i) = FR*FR* (Y (i+1) - 2* Y(i) + Y (i-1))
aZ1 (i) = FR*FR* (Z (i+1) - 2* Z(i) + Z (i-1))

For Frames Factor of 5:

aX1 (i) = FR*FR* (X (i+2) - 2* X(i) + X (i-2)) / 4
aY1 (i) = FR*FR* (Y (i+2) - 2* Y(i) + Y (i-2)) / 4
aZ1 (i) = FR*FR* (Z (i+2) - 2* Z(i) + Z (i-2)) / 4

For Frames Factor of 7:

aX1 (i) = FR*FR* (X (i+3) - 2* X(i) + X (i-3)) / 9
aY1 (i) = FR*FR* (Y (i+3) - 2* Y(i) + Y (i-3)) / 9
aZ1 (i) = FR*FR* (Z (i+3) - 2* Z(i) + Z (i-3)) / 9

For Frames Factor of 9:

aX1 (i) = FR*FR* (X (i+4) - 2* X(i) + X (i-4)) / 16
aY1 (i) = FR*FR* (Y (i+4) - 2* Y(i) + Y (i-4)) / 16
aZ1 (i) = FR*FR* (Z (i+4) - 2* Z(i) + Z (i-4)) / 16

Resultant acceleration scalar:

aR1 (frame i) = SQRT(aX1**2 + aY1**2 + aZ1**2)

Binary Files—ANB, TRB, and C3D

The following are binary files and cannot be directly read or manipulated by the end user. Their function and context are briefly described.

ANB—Analog Binary

These files contain up to 64 channels of analog data collected simultaneously with video data by the optional analog board. The data in these files can be converted to readable ASCII form as either an ANA or ANC file. To do so, from the main menu select **File > Export > Export ANC.**

Note: The data contained in the ***.anb** file has a dynamic range of –2048 to +2047, which represents 12 bit signed numbers. **Cortex** scales the specified input voltage range to this range of values.

TRB—Track Binary

These files contain the same 3D track data as ASCII **.trc** files, saved in a compact binary form. In addition to the data in **.trc** files, **.trb** files contain the following data for each frame:

- a list of the cameras used to calculate the 3D marker position
- the residual of the 3D position calculation

C3D

These are a special binary files that contains both scaled 3D track data and unscaled analog data. For more information, you can visit the C3D website at www.c3d.org.

Appendix F SIMM Motion Module

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Introduction

The Motion Module is an optional component to SIMM (Software for Interactive Musculoskeletal Modeling) that allows you to easily import data recorded by a motion capture system. It reads files containing tracked marker data (3D positions of markers in global space) using the TRC or TRB file format developed by Motion Analysis Corporation. It can also read analog files in the ANB or ANC format with ground-reaction force and EMG data that was recorded in sync with the motion. The Motion Module can also read C3D files, which contain both tracked marker and analog data in the same file. Additionally, the real-time version of the Motion Module can connect to a Motion Analysis system and receive and display motion and analog data in real-time, as it is being recorded.

Files of tracked marker data contain a sequence of frames, each representing a snapshot of the subject's motion at a particular instant in time. Each frame contains the X, Y, and Z coordinates, expressed in a global coordinate system, of all the identified markers. A frame of marker data can thus be thought of as a "marker cloud" because the coordinates are not organized by body segment.

The Motion Module imports tracked marker data and fits a SIMM model within the marker cloud for each time frame. If the SIMM model contains markers whose names and positions match those of the markers placed on the subject, the Motion Module can adjust the model's gencoord values to determine a "best fit" of the model to the marker cloud. The quality of a fit is determined by how closely each of the model's markers is to its corresponding marker in the marker cloud. It then uses this best fit as the starting position for solving the next frame of data. The result is a SIMM motion that matches the tracked marker data. The model that is used to fit the data can either be one that you create or the pre-made model (the *mocap model*) that comes with the Motion Module.

The Motion Module has two primary components. The first component reads files containing tracked marker data (in the TRC, TRB, or C3D format) and creates SIMM motions from them, as described above. For more information on how this process works, and the various options for importing marker data, reference the *SIMM User's Guide*.

The second component of the Motion Module creates a musculoskeletal model of a given individual by scaling a generic full-body model (the *mocap model*) based on tracked marker data from a static pose. The algorithms that are used to scale the model are the same as those used in OrthoTrak, a full-body gait analysis package available from Motion Analysis. For more information on the mocap model and how it is created and used, see Section 5.3, Using the Mocap Model.

Opening Tracked Marker Files

SIMM can import tracked marker data that is stored in either a TRB or TRC data file. These file formats, described in the **EVa** and **Cortex** manuals, contain X, Y, and Z coordinates for each identified marker for each time frame. You can also import analog data files containing force plate and EMG data recorded during the motion. These analog data files can be in either the ANB or ANC formats. The Motion Module can also read XLS files containing other motion-related data that you may want to view in SIMM, such the kinetic data contained in an OrthoTrak single trial spreadsheet. For more information on importing analog and XLS files, see Section 5.2.3, Analog Data.

The Motion Module can also read C3D data files. These files contain tracked marker and analog data in the same file, so you only need to load one file to import all of your motion data from a trial.

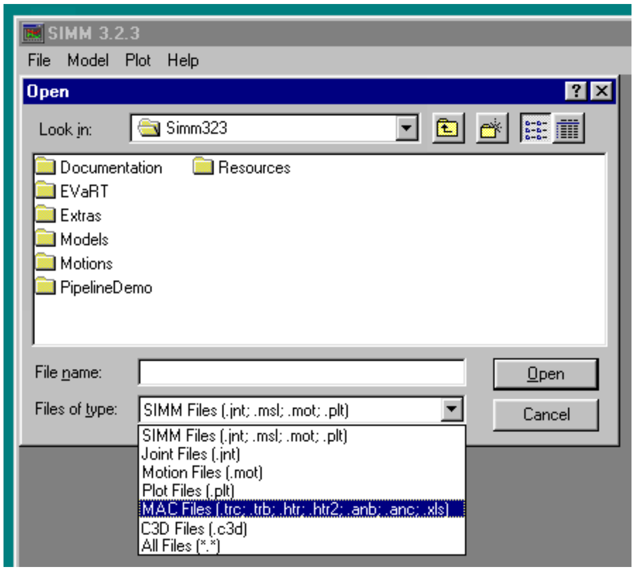
When you open a tracked marker file (along with any associated analog files), SIMM attempts to map the data onto the current musculoskeletal model, thus creating a SIMM motion that is linked to the model. Therefore, to open a tracked marker file, you must already have loaded into SIMM a model that contains the same marker set used in the marker file. For best results, you should make sure that every marker in the tracked marker file is also in the SIMM model, and that their locations in the SIMM model match where they were placed on the subject. The marker names should match exactly (except that they are case-insensitive). If the file contains markers that are not in the model, their data will be ignored by the Motion Module. Similarly, if the model contains markers that are not in the file, they will not be used to help fit the model to the motion data.

If you need to add, rename, or move markers in your SIMM model before loading a tracked marker file, you can use the Marker Editor to do so. See Section 2.12, Marker Editor, for more details.

Selecting Tracked Marker Files

To import a tracked marker file into SIMM, first make sure that the model you want to apply it to is the current model (the topmost window in SIMM). Then select **File > Open** from the menu bar. When the Windows® file browser appears, change the Files of Type popup menu at the bottom of the browser to **MAC Files** or to **C3D Files** then navigate to the folder containing the tracked marker file[s] you want to import.

Figure F-1. Windows File Browser


SIMM 3.2.3
File
Model
Plot
Help
Open
Look in:
Simm323
Documentation
EVaRT
Extras
Models
Motions
PipelineDemo
Resources
File name:
Files of type:
SIMM Files (.jnt; .msl; .mot; .plt)
Open
Cancel
SIMM Files (.jnt; .msl; .mot; .plt)
Joint Files (.jnt)
Motion Files (.mot)
Plot Files (.plt)
MAC Files (.trc; .trb; .htr; .htr2; .anb; .anc; .xls)
C3D Files (.c3d)
All Files (*.*)

Next, select the appropriate marker file[s] in the file browser. Click the **Open** button to import the file[s]. At this point SIMM will display a dialog box allowing you to specify several options for importing each data file into SIMM.

Note: If your analog data files have the same base name as your TRB/TRC file (*e.g.*, **subject14.trc, subject14.anb, and subject14.xls**), then it is not necessary to select analog files in the file browser. SIMM will automatically open any analog or XLS files with the same base name and in the same folder as the tracked marker file (there is an option in the dialog box to turn off this feature). If you are loading C3D files, this is not an issue since all of the data for the motion are stored in the C3D file.

Tracked Marker Options Dialog

Once you have selected one or more tracked marker files using the process described in the previous section, SIMM displays a dialog box for each one (in sequence), allowing you to set some options for importing the marker data. In many cases, you will want to use the default settings for these options, so you can simply click the **OK** button to import the motion. The following list describes each option in the dialog box.

Import Frames, To, Increment

These fields allow you to specify the range of frames to read from the marker file, as well as the increment. To use them, type into the first two fields the starting and ending frame numbers that you want to import. The third field specifies the increment to use when reading frames from the file. For example, to read every other frame from the file, enter an increment of 2. The starting frame number field and the increment field are initialized to 1. The ending frame number is initialized to the number of frames in the marker file.

Quick Solve

The Motion Module contains two optimization algorithms for fitting the musculoskeletal model to the marker data. The default method is fairly robust- it is designed to handle cases in which several markers are missing from a frame or in which the markers move large amounts between frames. The other method, called quick solve, is less robust but works up to twice as fast as the default method. If speed is an issue, and you know that your marker data is well-behaved, you may want to turn this option on to use the faster optimization algorithm.

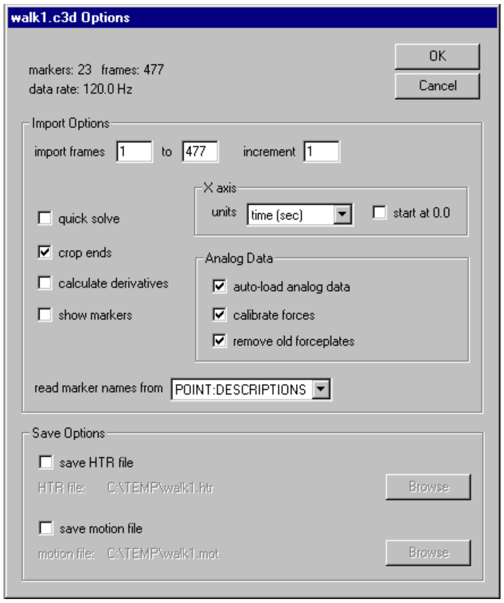
Crop Ends

Tracked marker data files often have frames at the beginning and end of a motion that are missing some markers (because the subject is outside the camera volume). To automatically detect and ignore these frames as the file is read, turn on this option (it is on by default). When the option is on, SIMM will start at the first frame and delete it if it is missing one or more markers. It will then continue to scan forward through the frames, deleting each one, until it encounters a frame containing all of the markers. It will then do the same procedure starting at the last frame and working backwards. SIMM will not remove frames with missing markers that are in between full frames, so there may still be frames in the motion that are missing markers.

Calculate Derivatives

When loading a motion, SIMM has the capability of calculating derivatives of the motion variables. When this option is turned on, after SIMM has solved the marker data and created a SIMM motion, it will calculate first-order time derivatives of the generalized coordinate values (*i.e.*, joint velocities) during the motion. It will also calculate derivatives of any force or EMG data in the analog file (if present). These derivatives can then be plotted using the Motion Curves command in the Plot Maker (see Section 2.5.2 for more details).

Figure F-2. Tracked Marker Import Dialog Box



walk1.c3d Options

markers: 23 frames: 477
data rate: 120.0 Hz

Import Options

import frames 1 to 477 increment 1

X axis
units time (sec) ☐ start at 0.0

☐ quick solve
☑ crop ends
☐ calculate derivatives
☐ show markers

Analog Data
☑ auto-load analog data
☑ calibrate forces
☑ remove old forceplates

read marker names from POINT:DESCRIPTIONS

Save Options

☐ save HTR file
HTR file: C:\TEMP\walk1.htr

☐ save motion file
motion file: C:\TEMP\walk1.mot

Show Markers

This checkbox turns on the display of the global marker positions in each frame when playing back a motion. When it is on, SIMM will add spherical motion objects to the motion, representing the location of each marker, as recorded in the marker file. When you animate the model according to the motion, the blue spheres represent these actual, recorded marker locations. These are the marker locations that the Motion Module is trying to fit the model to, for each frame. It can be helpful to display them in the model window in order to visualize how good the fit is, and to help debug problems with the data.

X Axis Units, Start at Zero

These options give you control over the specification of the X axis of the motion that is created from the marker data. The units along the X axis can be either time (in seconds), or frame number. The starting X value of the motion will be 0.0 if the units are time, and 1 if the units are frame number, unless frames of data are cropped because of missing markers (see “Crop Ends” on page F-4). For example, if 12 frames of data are cropped from the beginning of the motion (and the data frequency is 60 Hz), the starting X value will be 0.2 seconds for units of time, and 13 for units of frame number. If you want the X values to start at 0.0 (or 1 for frame number) even if frames are cropped, turn on the start at zero option.

Auto-Load Analog Data

When this box is checked, SIMM will look for and automatically load any analog (ANB, ANC) or XLS data files with the same base name as the TRB/TRC file. If SIMM did not detect the presence of any analog files when the TRB/TRC file was selected, this option is grayed out.

If you selected a C3D file with the file browser, then this box controls whether or not the analog data will be read from the C3D file.

Calibrate Forces

If an analog file is present, and the auto-load analog data box is checked (see above), then this box is active and gives you control over the calibration of the force plate data. When this box is checked, SIMM determines the baseline of each force plate channel and automatically subtracts these baseline values from the data, thus “zero-ing out” the force data.

Remove Old Force Plates

In order to display force plate data that is in the analog file, SIMM creates graphical objects in the model window representing the force plates. Each time you load a tracked marker file with corresponding analog data, SIMM creates a new graphical object for each force plate in the file. In most cases you will want to remove the existing force plate objects from the model when loading a new file, so that the display is not cluttered with multiple (or redundant) sets of objects. Thus this option is turned on by default. If you load a series of marker and analog files that all have the same force plate definitions, then you should leave this option turned on.

Read Marker Names From

For C3D import only: This option allows you to choose from which parameter field in the C3D file to read the names of the tracked markers. Because the `POINT:LABELS` field in a C3D file is limited to four characters, some software packages (*e.g.*, Cortex) store the full marker name in the `POINT:DESCRIPTIONS` field. Since the marker names in the tracked file must exactly match the names used in the mocap model, if your C3D file does not contain full marker names in the `POINT:DESCRIPTIONS` field, you may have to edit the mocap model so that the marker names match the four-character names stored in the `POINT:LABELS` field.

Save HTR File

This option allows you to save an HTR file containing the motion that SIMM calculates from the marker data. This HTR file cannot be read back into SIMM, but is useful if you want to import the motion into another software package. If this box is checked, a browse button is enabled that allows you to specify the name and location of the HTR file.

Save Motion File

This option allows you to save a SIMM motion file containing the motion that SIMM calculates from the marker data. This file contains exactly the same data that is in the motion that SIMM loads onto the model. You can load this motion file into SIMM at a later time, rather than re-importing the marker file. If this box is checked, a browse button is enabled that allows you to specify the name and location of the motion file.

Analog Data

Analog data files contain force plate and EMG data that was collected in sync with motion data. When loading C3D files, there are no separate analog files; all of the analog data is contained in the C3D file. When loading TRB/TRC files, you can load analog files only if they correspond to the chosen TRB/TRC files. If the analog file has the same base name as the TRB/TRC file, then the Motion Module will load it automatically when you select the marker file. Otherwise, you should select the analog file as well in the file browser. The same holds for XLS files, which are not actually analog files, but are treated similarly. XLS files can contain other data corresponding to the recorded motion, such as kinetic data calculated by OrthoTrak and stored in a “single trial spreadsheet.”

SIMM can recognize three types of analog data: ground reaction forces, EMG activation levels, and “other” data (usually kinetic data from an XLS file). These data types, and how they are interpreted by SIMM, are described below:

Force Plate Data

SIMM displays force plate data by drawing a vector in the model window at the appropriate point of application and with a size corresponding to the magnitude of the force. force plate data in an analog file are voltages measured by force plate transducers. These voltages are converted into forces using a calibration file, **forcepla.cal**. This file is the same one used by EVa, Cortex, and OrthoTrak. To use it with SIMM, you should put a copy of it in the same folder as your motion data, or in the folder **SIMM\Resources\ mocap\misc**. If you have only one force plate configuration for your motion capture system, it is preferable to put *forcepla.cal* in **SIMM\Resources\mocap\misc,** rather than copying it into every folder of motion data.

Note: C3D files that contain force plate data also contain the calibration information for the plates. Thus there is no separate calibration file that SIMM reads when importing C3D files.

SIMM also uses another configuration file, **importVariables.txt**, to map force plate channels to SIMM variables. This file is located in **SIMM\Resources\mocap\misc**, and contains mappings for typical channel names for up to six force plates. You will only need to change this file if you use more than six force plates, or use force plates that have exotic channel configurations. This file is used when loading ANB/ANC files and when loading C3D files.

EMG Data

SIMM displays EMG data by varying the sizes and colors of the corresponding muscles in the SIMM model. EMG data in an analog file are voltages measured by the EMG system. SIMM rectifies and smooths these data, and then scales them based on an MVC value (maximum voluntary contraction), resulting in a smooth muscle excitation level that varies between 0.0 and 1.0. If MVC values are located in the configuration file **importVariables.txt**, SIMM will use them to scale the EMG data. If MVC values are not present, SIMM will use each muscle's maximum voltage in the analog file to scale that muscle's EMG data (thus each muscle's excitation will peak at 1.0 sometime during the motion). The file **importVariables.txt,** located in **SIMM\Resources\mocap\misc**, contains mappings between typical EMG channel names and the muscle names in the mocap model. It does not contain any MVC values. In most cases, however, it is sufficient to not specify them and use SIMM's default scaling method.

Other Data

"Other" data is contained in XLS files, and can represent any motion variable that you choose to calculate and store in the file. It is usually reserved for kinetic data (*e.g.*, joint moments and powers) that OrthoTrak calculates and stores in its spreadsheet (XLS) format. It may also include motion events, such as toe-off and heelstrike, that are stored at the top of the XLS file. SIMM does not perform any calculations on these data, but does import them so that you can create plots of them in the Plot Maker. SIMM will only import "other" data that are identified as such in **importVariables.txt**. This configuration file, located in **SIMM\Resources\mocap\misc**, contains mappings between OrthoTrak and the mocap model of all forces, moments, and powers for the hip, knee, and ankle joints. You will only need to edit this file if you want to import data other than these.

Real-time Import

In addition to importing tracked marker files, SIMM can import motion data that is sent over the network in real-time from Cortex. SIMM is thus able to animate a musculoskeletal model and plots of joint angles and muscle lengths while the subject's motion is being recorded. For this real-time connection, **Cortex** solves tracked marker data using the mocap model. It then sends generalized coordinate values (as well as analog data) over the network to the SIMM computer. If the same mocap model is loaded into SIMM, these generalized coordinates will drive the animation of the model in real-time, with a small delay (whose length depends on the network speed and the graphics speed of the SIMM computer).

Follow these steps to use the real-time connection between Cortex and SIMM:

First-time setup only:

1. Find the folder **SIMM\Cortex** on your SIMM computer and look for **mocap.jnt** and **solver.dll** (**solver.dll** may be hidden in the folder view because it is a system file). Copy both files to the folder on the **Cortex** machine (you'll need to exit **Cortex** first, if it is running). This will guarantee that **Cortex** is using the same mocap model and the same scaling algorithms as SIMM uses.

2. Open the text file **SIMM\Resources\preferences** in a text editor such as Notepad or Wordpad. Locate the line that reads: `Cortex_MACHINE <hostname>`, and change the hostname to the name of your **Cortex** machine. Save and close the preferences file (make sure that the file is saved as ASCII text with the name preferences—Wordpad likes to surreptitiously append a **.txt** extension when it saves files that don't already have a filename extension).
3. If your motion capture system includes force plates, copy the file **forcepla.cal** from your **Cortex** computer onto your SIMM computer and put it in the folder **SIMM\Resources\mocap\misc**.

Each motion capture session:

4. Copy the folder containing the motion data from the Cortex computer to the SIMM computer (or make it shared). If there is a **personal.dat** file for this data, make sure it is in the folder too.
5. Launch **Cortex**. Load the appropriate capture.
6. Select **File > Load Capture** and select the tracked marker file corresponding to the static trial for the subject.
7. Under **System > Misc**, click on the radio button for **SIMM OrthoTrak Solver**, located in the Skeleton Options area.
8. Launch SIMM.
9. Select **File > Open Mocap Model** and navigate to the motion folder. Choose the tracked marker file containing the static pose.
10. Set the options as desired in the dialog box and click **OK**.
11. Open the Model Viewer window.
12. In the Model Viewer window, choose **Start > Realtime Connection to <hostname>**. SIMM will display a dialog box allowing you to set some options for the connection. The motion buffer size options control how many seconds of motion data are saved in SIMM’s buffer. The *time scale* options let you specify the minimum and maximum values, in seconds, for the time scale of the motion. If you want the scale to remain fixed between minimum and maximum, check the sliding checkbox, otherwise the scale will continue to increase as new data is received.
13. SIMM will now wait to receive data from the **Cortex** computer. Once the connection is established, SIMM will display “connected” in its message window, and the SIMM model will begin tracking the motion of the subject in real-time. You can pan, zoom, rotate, and change the draw mode of the SIMM model as it is tracking the motion. You can also create plots of kinematic variables and muscle properties and see the plots change in real-time.
14. To disconnect SIMM from the real-time stream, click the **Stop** button in the Model Viewer. You can play back the last N seconds of the motion.

Note: When analog data is imported into SIMM in real-time, it is processed slightly differently than when the data is post-processed in SIMM. This is because the real-time analog data is processed frame-by-frame, without the benefit of the full data set. This has the following implications:

- To set the baseline for the force plates, the first frame of force data is used as the “zero” level. Thus when you first connect SIMM to **Cortex**, you should make sure that nothing is on the force plates.

- If no MVC levels have been specified for some of the muscles, a running tally of each muscle's maximum level will be kept, and used to scale the EMG signals into the range 0.0 to 1.0. Thus if you want to accurately scale EMG levels throughout a real-time SIMM motion import, you should either specify MVC levels, or have the subject perform MVCs just after connecting SIMM to Cortex.

Using the Mocap Model

SIMM has the ability to read tracked marker data and convert it into a motion by fitting a musculoskeletal model to it. For this to work well, the body segment lengths, marker names, and marker locations in the model must exactly match those for the subject whose motion is being recorded. Because it is time consuming to measure and scale the body segments, and measure and record the offsets of all of the markers, the Motion Module has the ability to automatically scale a pre-made model (the mocap model) to fit the subject.

To use the mocap model, select **Open Mocap Model** from the **File** menu. SIMM will display a Windows® file browser and ask you to select the name of a static pose file. This static pose is used to calculate joint center locations and segment lengths for the subject, using the same algorithms implemented in OrthoTrak. In other words, *the Motion Module recreates the OrthoTrak skeletal model from the static pose, and then maps this skeletal model onto the mocap model*. Thus to use the mocap model, you need to use the same motion capture protocol as you would for OrthoTrak. You can use either the Helen Hayes or Cleveland Clinic marker sets (plus your own additional markers, if desired), as long as the marker names and locations match the protocol defined in the OrthoTrak manual. The Motion Module uses the tracked marker data from the OrthoTrak static pose, and also segment information from **personal.dat,** to scale the mocap model to the subject. The algorithms for calculating joint center locations and segment lengths have been designed to be as similar as possible to the OrthoTrak algorithms. This was done so that motion information in SIMM (*e.g.*, joint angles, EMG levels) would match the corresponding information in OrthoTrak, and also so that you would not have to change your OrthoTrak protocol in order to use SIMM.

The mocap model and the algorithms used to scale it are described in the following sections.

The Mocap Model

The mocap model is a full-body SIMM model that has been customized for gait analysis, but can be used to import and display any type of full-body motion. The model has 41 body segments, 41 joints, 40 degrees of freedom, and 88 lower-extremity muscles. It represents an adult male, approximately 175 cm. tall, with a mass of 78 kg. The model is scaled to match the size of the motion capture subject using algorithms described in Section 5.3.4. The model's joints have been carefully constructed to represent normal joint motion as closely as possible.

To load the mocap model into SIMM, the software looks for the `MOCAP_MODEL` variable in the preferences file (**SIMM\Resources\preferences**) to get the name of the joint file that comprises the mocap model. The default setting for this variable is **SIMM\Resources\**

mocap\mocap.jnt. This joint file includes the file **mocap.msl** to get the definitions of the muscles.

You may change the mocap model however you wish. For example, you can add or remove muscles from the model, or change the tendon and fiber parameters of existing muscles. You can also add degrees of freedom to the model, in order to more accurately represent a particular motion (*e.g.*, adding toe joints and gencoords to examine toe motion in greater detail). If you modify the mocap model, however, you should keep in mind two things.

First, the model has been set up to correspond to the skeletal model that OrthoTrak uses when processing gait data. The lower-extremity body segments and orientations of the reference frames closely match those in the OrthoTrak model. Also, each body segment in the mocap model is scaled to fit the subject by relating its length to the length of an OrthoTrak segment. These relations are specified in the mocap model by defining scale segments and scale factors for each body segment. If you add, delete, or modify joints or body segments in the mocap model, you should make sure that each segment still properly relates to an OrthoTrak segment.

Second, **mocap.jnt** contains several macros that are used to properly define the orientation of the floor, and to automatically remove the upper body segments if there are no upper body markers. When SIMM reads a joint file, it performs these macros but does not save them internally. Thus when it writes out a joint file, all of the macros have been removed. If you make changes to the mocap model in SIMM and then save the new model to a file, do not replace *mocap.jnt* with the new file. Instead, copy the relevant portions of the new file into *mocap.jnt* using a text editor, thus preserving the macros and comments.

The Static Pose

When you open the mocap model, SIMM prompts you for the name of a tracked marker file containing a static pose of the subject. This static pose is the same one used by OrthoTrak, and for it you can use any of the six marker sets identified by that software package: *Cleveland Clinic Lower Body*, *Cleveland Clinic Full Body*, *Cleveland Clinic Full Body with Head*, *Helen Hayes Lower Body*, *Helen Hayes Full Body*, and *Helen Hayes Full Body with Head*. It is also strongly recommended that you include the medial knee and ankle markers in the static pose, for more accurate calculation of knee and ankle joint centers. You can also supplement the OrthoTrak marker set with your own custom markers, as long as you do not move or remove any markers from the identified set. Lastly, the marker set used in the static trial must include all of the markers you plan to use for capturing motion. This is because the Motion Module calculates the locations of all markers in the mocap model based on their locations in the static trial. These are the steps you should follow when collecting the static trial:

1. Choose which of the six OrthoTrak marker sets you would like to use for capturing motion.
2. Add the medial knee and ankle markers, for better calculation of knee and ankle centers (not required, but highly recommended).
3. Add any additional markers that you would like to use (*e.g.*, extra markers on the feet, more markers on the arms). These markers must also be added to the mocap model, The Marker Set.

4. Capture the static trial using the protocol outlined in the OrthoTrak manual. The subject should have their arms either down by their sides, or straight out from their body with their thumbs facing forward.
5. Remove the medial knee and ankle markers, and any others that you do not want to use for capturing motion.

Note: If you use a marker set with no upper extremity markers, the Motion Module will remove the upper extremity from the mocap model and display only the pelvis and legs.

Once you have selected the static pose file to be used for opening the mocap model, SIMM displays a dialog box, allowing you to set some options for importing the static pose. In many cases, you will want to use the default settings for these options, so you can simply click the *OK* button to import the motion. The following list describes each option in the dialog box:

average from frame These fields allow you to specify the starting and ending numbers for the sequence of frames that are averaged together to determine the static pose. These fields are initialized to 1 and the number of frames in the file, meaning that all frames will be averaged. If frames in the chosen sequence are missing some markers, locations for markers that are present will still be used in the average.

load personal.dat This option gives you control over the automatic loading of **personal.dat.** When SIMM loads the static marker file, it looks for a file called **personal.dat** in the same folder. This file is identical to the one created and used by OrthoTrak. If the file is present, SIMM will automatically load it and read model parameters from it, such as foot length and hip origin offsets. It will use these parameters to determine joint center locations and segment lengths, using the same algorithms that OrthoTrak does. If there is no **personal.dat** file present in the folder, this option will be grayed out. If it is checked and you do not want to load **personal.dat**, click the box to turn it off.

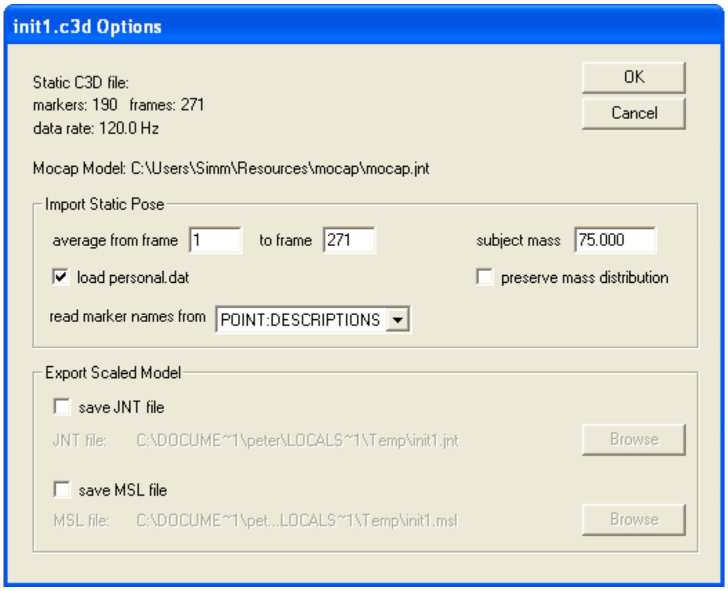
read marker names from **For C3D import only:** This option allows you to choose from which parameter field in the C3D file to read the names of the tracked markers. Because the `POINT:LABELS` field in a C3D file is limited to four characters, some software packages (*e.g.*, **Cortex**) store the full marker name in the `POINT:DESCRIPTIONS` field. Since the marker names in the tracked file must exactly match the names used in the mocap model, if your C3D file does not contain full marker names in the `POINT:DESCRIPTIONS` field, you may have to edit the mocap model so that the marker names match the four-character names stored in the `POINT:LABELS` field.

subject mass This field allows you to specify the total mass of the model after it has been scaled to fit the size of the subject. After the scaling is done, all the body segments' mass parameters are scaled up or down by a single percentage so that the total mass of the model equals the number entered into this field. This field has no effect if mass properties are not specified in the model file.

preserve mass distribution

This option gives you control over how the mass properties of the individual body segments are scaled. If this option is off, then each body segment's mass is scaled proportionally with its size. If this option is on, then each segment's mass parameters are not scaled with their change in size (i.e., the distribution of body mass specified in the model file is preserved). In either case, after the model has been scaled, all the body segments' mass parameters are scaled up or down by a single percentage so that the total mass of the model equals the number entered into the "subject mass" field.

Figure F-3. Static Trial Import Dialog Box



init1.c3d Options

Static C3D file:
markers: 190 frames: 271
data rate: 120.0 Hz

Mocap Model: C:\Users\Simm\Resources\mocap\mocap.jnt

Import Static Pose

average from frame 1 to frame 271 subject mass 75.000
☑ load personal.dat ☐ preserve mass distribution
read marker names from POINT:DESCRIPTIONS

Export Scaled Model

☐ save JNT file
JNT file: C:\DOCUME~1\peter\LOCALS~1\Temp\init1.jnt

☐ save MSL file
MSL file: C:\DOCUME~1\pet...LOCALS~1\Temp\init1.msl

Save JNT File, Save MSL File

These options allows you to specify if SIMM will write out joint and muscle files containing the musculoskeletal model that is scaled to fit the subject. After SIMM has loaded the mocap model and scaled it based on the data in the static marker file and **personal.dat**, it will write out corresponding joint and muscle files, depending on the states of these check boxes. You may want to create these files so that you can make changes to them or to be able to re-load the model without going through the scaling process again.

Calculation of Joint Centers

Once the static pose has been loaded, the Motion Module recreates the OrthoTrak skeletal model from the marker cloud. The first step is determining the locations of the joint centers for all of the joints in the OrthoTrak model. The pelvis, hip, knee, and ankle centers are all found using the same procedure used by OrthoTrak.

The hip center is determined using percentage offsets from the pelvis markers. The Motion Module reads these offsets from **personal.dat**, as written by OrthoTrak. The default values for these offsets are taken from *Bell et al. Journal of Biomechanics, 23(6), 1990, pp. 617-21*:

posterior displacement: 22%
lateral displacement: 32%
inferior displacement: 34%

To change these values, edit the file **personal.dat,** as described in Appendix D of the OrthoTrak manual.

The knee and ankle centers are found using the medial and lateral markers. It is strongly recommended that you use medial markers for a more accurate calculation of joint centers. If you choose not to use them, you should enter knee and ankle diameter measurements into **personal.dat**. The Motion Module will use them to locate the knee and ankle centers if no medial markers are used.

The default method for determining shoulder, elbow, and wrist joint centers uses percentage offsets from the appropriate marker locations. If medial elbow and wrist markers are used in the static trial, their locations are averaged to get the joint centers, as is done with the knee and ankle. It is recommended that you use medial elbow and wrist markers in the static trial if you want an accurate representation of arm motion.

Scaling the Mocap Model

Once the locations of the OrthoTrak joint centers have been calculated from the static pose, the Motion Module determines the orientations of the OrthoTrak segment reference frames. It then can measure the lengths of the OrthoTrak segments and use them to scale the mocap model to match the size of the subject.

The reference frames for the foot, shank, thigh, pelvis, and torso are all determined using the procedure described in Appendix H of the OrthoTrak manual.

OrthoTrak does not create reference frames for the upper and lower arms, but the Motion Module does this using one of several methods. If medial elbow and wrist markers are used in the static trial, then the arm reference frames are found in the same way in which the thigh frames are found. If no medial markers are present, then the upper and lower arm reference frames are found using the line between the joint centers as the X axis, and using the same Y axis as the torso. The Z axis is then determined by crossing X and Y.

Once all of the segment reference frames have been determined, the length of each segment is calculated. For most segments, the length is simply the distance from one joint center to the next. For the foot, the Motion Module reads the length from **personal.dat.** If there are no foot length measurements in **personal.dat**, then the foot length is assumed to be 1.4 times the distance from the heel marker to the toe marker (the toe marker is actually placed on the top of the foot just posterior to the toes).

Each body segment in the mocap model contains scaling information that tells the Motion Module how to scale it based on an OrthoTrak skeletal segment. The scaling information consists of the name of the OrthoTrak segment and X, Y, and Z reference numbers that correspond to the unscaled length of the SIMM segment. For example, the right femur in the mocap model contains the line:

gait_scale R_THIGH 0.3960 0.3960 0.3960

This tells the Motion Module that the unscaled femur is 0.3960 meters long. Once the length of the corresponding OrthoTrak segment is known (R_THIGH), the femur can be scaled accordingly. If the R_THIGH segment were 0.35 meters long, then the femur would be scaled by a factor of 0.35/0.396. In most cases the three reference values are the same number, indicating that the segment should be scaled uniformly in X, Y, and Z. The two exceptions are the TORSO and PELVIS, which are scaled differently in two dimensions. For SIMM segments that do not map directly to an OrthoTrak segment, their scaling information is copied from the most relevant segment. For example, the right hand in the mocap model copies the scaling information from the right lower arm, so that the hand is scaled the same amount as the lower arm.

The Marker Set

The marker set in the mocap model that comes with SIMM includes every marker used in all six marker sets that OrthoTrak recognizes, plus the medial knee and ankle markers. In addition, many other markers have been added, such as medial elbow and wrist markers. For a complete list of the markers in the model, as well as information on when they should be used and where they should be placed on the subject, read the *Guide to Mocap Model Markers* document. The mocap model contains over 80 markers, which is more than the number used in most applications. When the static trial is loaded, any marker in the mocap model which is not in the static trial is removed from the model. Thus it is not a problem to have extra markers in the mocap model. In fact, you should add to the model whatever extra markers you may need for any of your motion capture applications. Then for a particular application the mocap model will have all the necessary markers, and the unused ones will automatically be removed when the model is loaded into SIMM.

To add or change markers in the mocap model, use the Marker Editor. You should be careful not to overwrite the original **mocap.jnt** file. Instead, after editing the marker set, save the model to a new file name, and copy the altered markers into **mocap.jnt**.

All of the markers in the mocap model have X, Y, and Z offsets that put them in realistic locations given the dimensions of the generic model. Thus if you load the unscaled mocap model into SIMM (using the **File > Open** command, not the **File > Open Mocap Model** command, which will scale it), the markers will appear in positions corresponding to where they are placed on the subject. *These offsets are purely decorative, to help you view the marker set. They are not used by the Motion Mod-*

ule to process any marker data. To explain why this is so, we must first introduce the concept of *critical* markers and *non-critical* markers.

Critical markers are ones that must be present in the static trial in order for the Motion Module to load and scale the mocap model. For the lower body, these markers are: V.Sacral, R.ASIS, L.ASIS, R.Knee (or R.Knee.Lateral), R.Ankle (or R.Ankle.Lateral), R.Heel, R.Toe, L.Knee (or L.Knee.Lateral), L.Ankle (or L.Ankle.Lateral), L.Heel, and L.Toe. If any of these markers is missing from the static trial, the SIMM model of the lower body will not be loaded. For the upper body, the critical markers are: V.Sacral, R.ASIS, L.ASIS, R.Shoulder, R.Elbow, R.Wrist, L.Shoulder, L.Elbow, L.Wrist. Note that the ASIS and sacral markers are critical for both portions of the body. If one of these markers is missing from the static trial, you will get an error when trying to load the mocap model. Non-critical markers are all other markers in the set.

Once the Motion Module has determined the locations of the joint centers and the orientations of the segment reference frames from the static pose, it calculates the proper offsets for all of the critical markers (plus the static-only medial markers). For example, once the right thigh reference frame has been oriented within the static pose marker cloud, the exact positions of the critical markers attached to the right thigh can be measured directly from the static pose and entered into the mocap model, thus overwriting whatever offsets were in the model input file.

After the offsets of all the critical markers have been determined in this fashion, the mocap model is “fit” to the static pose marker cloud using only the critical markers to find the best fit. This process orients the mocap model within the marker cloud, so that the offsets of the non-critical markers can be measured directly from the static pose. These offsets are then entered into the model, overwriting whatever values were in the model input file.

To summarize, the Motion Module uses a two-step process to calculate proper offsets for all of the markers in the mocap model. The first step determines the offsets of the critical markers, which the OrthoTrak algorithms can definitively locate without knowing anything about the mocap model. Then these critical markers are placed on the mocap model, and the model is fit to the static pose marker cloud. Now the offsets of the other markers can be measured, because every body segment in the mocap model is now correctly placed in the static pose.

Analog Configuration Files

SIMM can include analog data such as ground reaction forces, EMG activation levels, and kinetic data when importing a motion. SIMM uses a configuration file named **importVariables.txt** to determine which analog variables to import from an analog file, and how the data for each variable should be interpreted. This configuration file is used for both TRB/TRC import (with corresponding ANB/ANC analog files) and for C3D import (where the analog data is contained in the C3D file itself). SIMM can interpret analog data as one of three types:

Force Plate Data

These variables specify voltages representing force or moment components as measured by a force plate transducer. Given the voltages generated by a force plate (6 channels for an AMTI or Bertec force plate, 8 channels for a Kistler force plate) SIMM can calculate and display a force location and vector for the force plate.

EMG Data

These variables define activation levels for one or more muscles in the SIMM full-body model. SIMM rectifies, smooths, and scales EMG data so that it can be plotted, and used to control the width and color of muscles during an animation.

Other Data

Any variables that are not force plate or EMG data are classified as other data. SIMM does not perform any calculations on these data variables, but they may be included in SIMM plots.

importVariables.txt

The **importVariables.txt** file, located in **SIMM\Resources\ mocap\misc**, contains a list of variable names and attributes. When SIMM processes an analog data file or an OrthoTrak XLS file, it consults the **importVariables.txt** file to decide which variables to import and how to interpret them.

Each row in **importVariables.txt** defines a variable to be imported. The first column in a row specifies the name of the variable as it appears in the analog or XLS data file. Since certain analog files support variable names with spaces in them, the first column of the **importVariables.txt** file *must* be terminated by a tab character. SIMM considers all characters from the beginning of a row until the first tab character to be the name of the import variable. SIMM does a case-insensitive comparison when matching variable names defined in **importVariables.txt** with variable names in an analog data file. Therefore the name “Rt Tibialis” would be considered the same as “rt tibialis”.

The second column in a variable definition specifies the type of the variable. It must be one of the following keywords: `force_plate`, `muscles`, or `other_data`. These keywords must be lowercase. Following each keyword is information describing the variable:

This keyword specifies a ground reaction force variable. It must be followed by three values:

1. The force plate number (`1`, `2`, `3`, etc.), then
2. The keywords `force` or `moment`, then

3. The channel component (`x`, `y`, or `z` for AMTI or Bertec force plates, or `x12`, `x34`, `y14`, `y23`, `z1`, `z2`, `z3`, `z4` for Kistler force plates).

This keyword specifies an EMG variable. It must be followed by one or more SIMM muscle names. The keyword `mvc` may optionally appear after the last muscle name. If `mvc` appears, then it must be followed by an integer number that SIMM uses as the voltage for the maximum voluntary contraction when scaling that EMG channel. If no MVC value is specified, then the channel is scaled such that its maximum value is 1.0. EMG scaling is performed after the EMG channel's data has been smoothed and resampled to the motion's frequency.

This keyword specifies a data channel that exists simply to be included in SIMM plots. This keyword may be optionally followed by a single word that will be used to label this channel in SIMM plots. If no name follows the `other_data` keyword, then the name of the imported variable will be used.

forcepla.cal

When importing analog data from ANB/ANC files, SIMM uses the same calibration file as Cortex and OrthoTrak for processing force plate data. Therefore, you can simply copy the **forcepla.cal** file from your Cortex folder into the **Resources\mocap\misc** folder. For users who need to create a **forcepla.cal** file to describe their force plate(s), refer to Appendix C of the OrthoTrak manual.

Note: **forcepla.cal** is not used for C3D import since C3D files contain the necessary calibration information for the force plates.

SIMM Motion Module Guide to Mocap Model Markers

This guide describes the markers used by the Motion Module in SIMM to load each Mocap Model, scale it to fit the subject, and import recorded motions. For details on how the Motion Module processes the marker data and the model, see Chapter 5 of the SIMM User Guide. For a tutorial of the Motion Module, click on Help-> SIMM Tutorials -> Motion Module Demo in the SIMM menu bar. This document focuses on the names and locations of the markers, and when they are needed by the Motion Module.

Definitions

Static Trial

A TRC, TRB, or C3D file of a motion capture subject in a static pose, usually the “T” or “scarecrow” pose

Motion Trial

A TRC, TRB, or C3D file of a subject performing an activity, such as walking or throwing

Mocap Model

A SIMM musculoskeletal model that can be loaded into SIMM, scaled to fit a subject using a static trial, and used to animate motion trials of that subject. The primary model is a full-body model with lower-extremity muscles, but others are available as well.

Critical Marker

A marker that is required in the static trial, and which must be placed in a specific location on the subject, according to instructions in the OrthoTrak manual. The coordinates of the marker in the static trial are used to determine joint centers and body segment lengths.

Semi-critical Marker

A marker that is optional in the static trial, but if used, must be placed in a specific location on the subject, according to instructions in the OrthoTrak manual. The coordinates of the marker in the static trial are used to improve the joint center calculations.

Optional Marker

A marker that is optional in the static trial, and whose placement on the subject does not need to be in a specific location

Fixed Marker

An optional marker whose X, Y, Z offsets are not automatically calculated when the static trial is processed. Rather, the offsets in the marker definition in the Mocap Model file are used to position the marker on the model (these offsets are scaled with the body segment, however).

The Motion Module comes with four different Mocap Models for you to choose from. Each of them contains parameters that turn on and off different portions of the model, depending on which of the critical markers are present in the static trial. When you load a Model Model with a static trial, the Motion Module reads the list of markers from the trial and sets the values of the model parameters so that the appropriate portions are included. For example, if the critical markers on the right hand are present, then the degrees of freedom in the fingers are activated. If they are not present, the hand is modeled as one rigid body segment, with movement only at the wrist.

The Mocap Model that you will most likely want to use is **mocap.jnt**. This is a model of a full body, with lower extremity muscles and [optionally] movable fingers in each hand. There is also a right arm model and a left arm model (**rightArm.jnt** and **leftArm.jnt**). These should be used if you want to capture motion of one arm without any torso or pelvis markers. Lastly, **mocap3D.jnt** is similar to **mocap.jnt**, but it includes 3D muscle surfaces for 18 key lower extremity muscles, rather than the lines of action for all 86 muscles. These muscle shapes look more realistic, but they do not have force-generating parameters, so you cannot calculate the lengths or forces in these muscles during the recorded motion.

Table F-1 on page F-19 shows the available combinations of model components. To determine which Mocap Model you should use, find the row that best describes the model you want, then locate the filename in the last column. All of these files are located in **SIMM\Resources\mocap**. Once you have determined which one to use, you can either set the MOCAP_MODEL variable in **SIMM\Resources\preferences** to that file, or choose that file using the **Options...Choose Model Model** command in the SIMM menu bar.

Table F-1. Combinations for Model Components

lower extremity	upper extremity	movable fingers	muscles	file name
yes	yes	yes	legs only	mocap.jnt
yes	yes	no	legs only	mocap.jnt
yes	no	no	legs only	mocap.jnt
no	yes	yes	none	mocap.jnt
no	yes	no	none	mocap.jnt
no	right arm only	yes	none	rightArm.jnt
no	right arm only	no	none	rightArm.jnt
no	left arm only	yes	none	leftArm.jnt
no	left arm only	no	none	leftArm.jnt
yes	yes	yes	legs only, 3D	mocap3D.jnt
yes	yes	no	legs only, 3D	mocap3D.jnt
yes	no	no	legs only, 3D	mocap3D.jnt

It is important to note that *the critical and semi-critical labels for markers are relevant only for the static trial. For motion trials, all markers are optional.* That is, after recording the static trial, you can remove any of the markers from the subject before recording motion trials. Generally, however, you will want to keep all of the markers on the subject for the motion trials, with the possible exception of the medial joint markers. Also, once the static trial has been recorded, you must be careful not to move any of the markers on the subject (except for removing them completely). SIMM uses the static trial to calculate the coordinates of each marker relative to its body segment, so if you move a marker or add additional markers, you must re-record the static trial and re-load the Mocap Model.

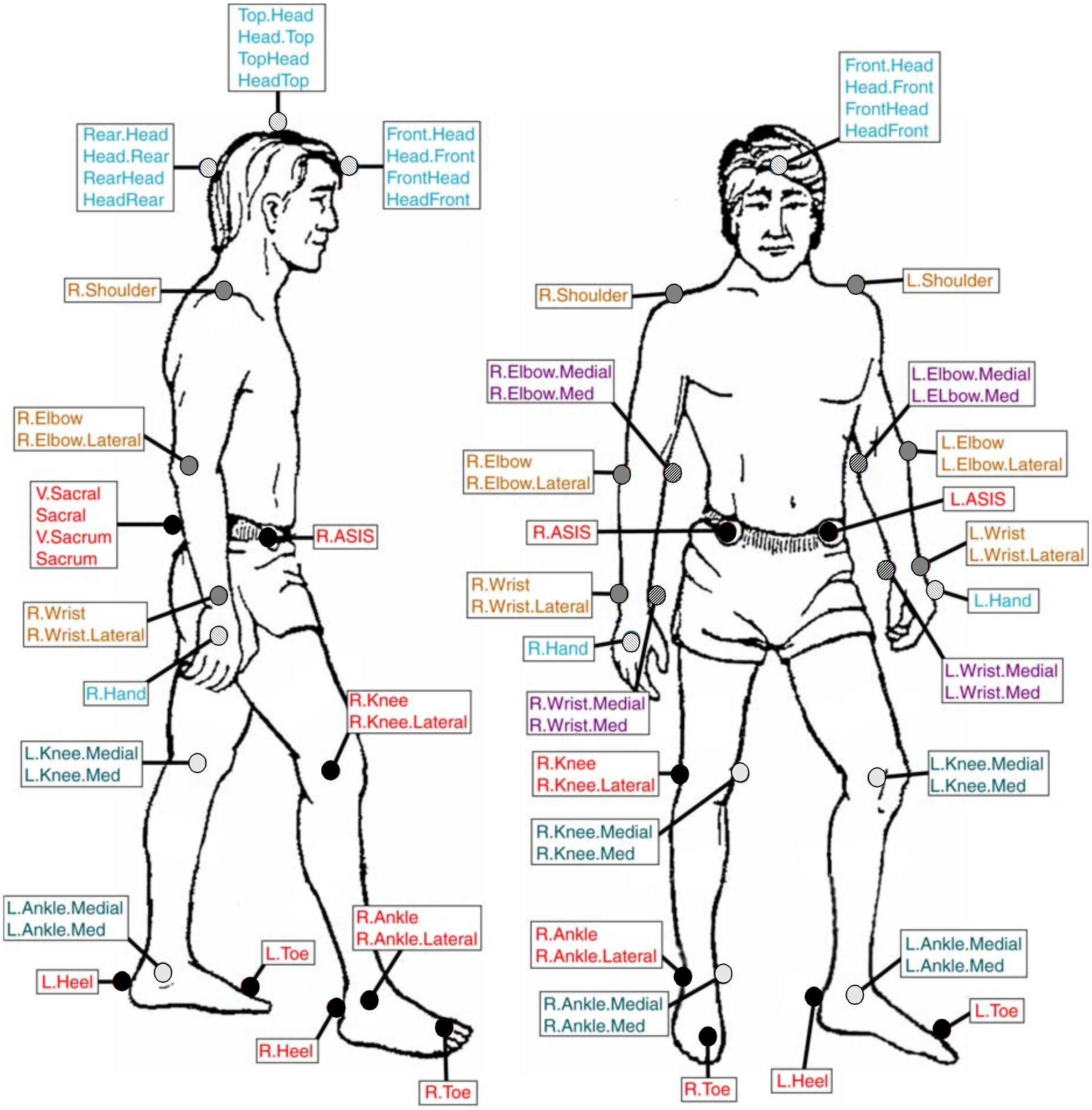
All of the markers described in this document are already part of the primary Mocap Model, located in *SIMM\Resources\mocap\mocap.jnt*. To use any of them, you do not need to make any changes to the file; just place the markers on the appropriate locations on the subject, and make sure the marker names in the static trial match the names shown in the figures below. Many of the markers can have one of several names, as listed in the box pointing to each marker in the figures. These names are case-insensitive, and may contain spaces.

If you want to add markers to the Mocap Model, you can do so with the Marker Editor in SIMM. This tool allows you to create new markers, attach them to the appropriate body segments, and specify their X,Y, Z offsets. The exact values of the offsets are not important; they are used only for display of the marker while creating it. The offsets will be overwritten with values calculated by the Motion Module when the static trial is processed and the model is scaled to fit the subject. This process is described in more detail in Chapter 5 of the SIMM User Guide, but here is a brief summary. After loading the static trial, the Motion Module places all of the critical markers that are in the trial on the Mocap Model in their corresponding locations. The Mocap Model is then scaled to match the subject, and then a least-squares optimization fits the model within the cloud of static trial markers, considering only the critical markers. This positions the model within the marker cloud so that the Motion Module can then directly calculate the offsets from the optional markers to the model segments to which they are attached. If you do not want the offsets for a marker to be calculated in this manner, then you must turn on the “fixed” button for that marker in the Marker Editor, and enter accurate X, Y, Z offsets into the number fields. This tells the Motion Module to scale the marker’s offsets when the model is scaled, but not to recalculate their values as it does for the other optional markers.

Note on adding markers: You can create new markers using the Marker Editor, and then save the model by writing out a joint file, but you should not replace the original model file (*e.g.*, **SIMM\Resources\mocap\mocap.jnt**) with this new file. This is because the model file contains many comments and special parameters that enable SIMM to automatically modify it for a particular static trial, as described above. However, when this file is loaded into SIMM and then written back out, these comments and parameters are lost. Thus after saving your new joint file, you should use a text editor to copy the new marker definitions from the file and paste them into the existing model file.

Shown in Figure F-4 on page F-21 are the critical and semi-critical markers for upper body and lower body motion recording. If any of the lower body critical markers is missing from the static trial, the legs will not be loaded with the Mocap Model. Similarly, if any of the upper body critical markers is missing from the static trial, the torso, head, and arms will not be loaded. Note that the sacral, left ASIS, and right ASIS markers are critical for both upper and lower body motion recording. If any of these markers is missing, the Motion Module will print an error and not load the Mocap Model. The head and hand markers are semi-critical. If used, they allow the Motion Module to track motion at the neck and wrist. If not used, these joints will remain fixed during animation of motion trials in SIMM.

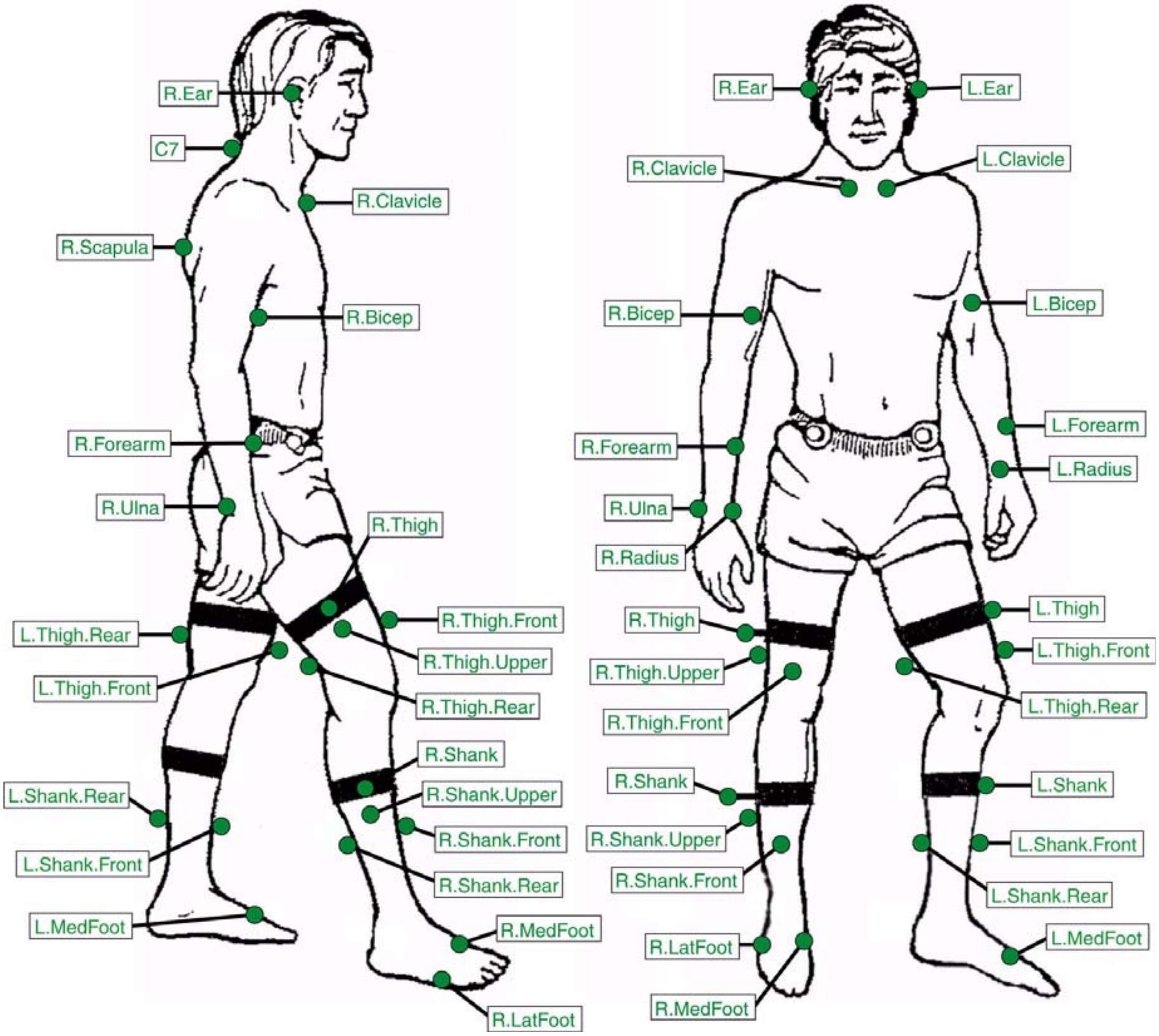
Figure F-4. Critical and Semi-Critical Markers


Top.Head
Head.Top
TopHead
HeadTop
Rear.Head
Head.Rear
RearHead
HeadRear
Front.Head
Head.Front
FrontHead
HeadFront
R.Shoulder
R.Elbow
R.Elbow.Lateral
V.Sacral
Sacral
V.Sacrum
Sacrum
R.ASIS
R.Wrist
R.Wrist.Lateral
R.Hand
R.Knee
R.Knee.Lateral
L.Knee.Medial
L.Knee.Med
L.Ankle.Medial
L.Ankle.Med
L.Heel
L.Toe
R.Ankle
R.Ankle.Lateral
R.Heel
R.Toe
Front.Head
Head.Front
FrontHead
HeadFront
R.Shoulder
L.Shoulder
R.Elbow.Medial
R.Elbow.Med
L.Elbow.Medial
L.ELbow.Med
R.Elbow
R.Elbow.Lateral
L.Elbow
L.Elbow.Lateral
L.ASIS
R.ASIS
L.Wrist
L.Wrist.Lateral
R.Wrist
R.Wrist.Lateral
L.Hand
R.Hand
L.Wrist.Medial
L.Wrist.Med
R.Wrist.Medial
R.Wrist.Med
R.Knee
R.Knee.Lateral
L.Knee.Medial
L.Knee.Med
R.Knee.Medial
R.Knee.Med
R.Ankle
R.Ankle.Lateral
L.Ankle.Medial
L.Ankle.Med
R.Ankle.Medial
R.Ankle.Med
L.Toe
R.Toe
L.Heel

● Critical lower extremity markers
◉ Critical upper extremity markers
○ Semi-critical lower extremity markers that improve joint center calculations
◍ Semi-critical upper extremity markers that improve joint center calculations
◌ Semi-critical upper extremity markers that allow for additional degrees of freedom

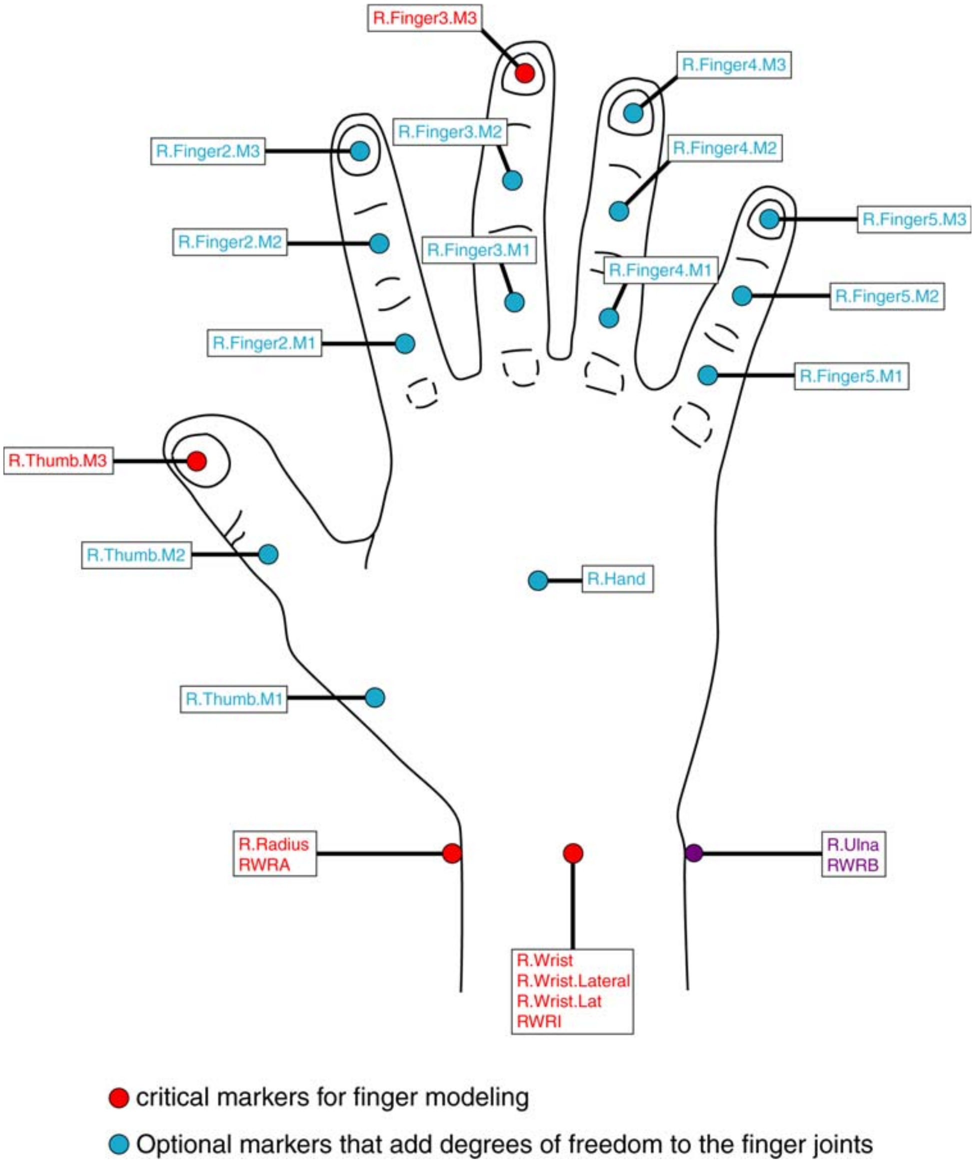
The markers shown in Figure F-5 are optional. If any of these markers is in the static trial, its location on the corresponding body segment in the Mocap Model will automatically be determined after the model has been scaled using the critical markers (*i.e.*, these optional markers are not "fixed," so their X, Y, Z offsets in the model file will be overwritten when the model is loaded). These markers will then be used to help solve the frames of data in a motion trial.

Figure F-5. Optional Markers


R.Ear
C7
R.Clavicle
R.Scapula
R.Bicep
R.Forearm
R.Ulna
R.Thigh
L.Thigh.Rear
R.Thigh.Front
R.Thigh.Upper
L.Thigh.Front
R.Thigh.Rear
R.Shank
L.Shank.Rear
R.Shank.Upper
R.Shank.Front
L.Shank.Front
R.Shank.Rear
L.MedFoot
R.MedFoot
R.LatFoot
R.Ear
L.Ear
R.Clavicle
L.Clavicle
R.Bicep
L.Bicep
R.Forearm
L.Forearm
L.Radius
R.Ulna
R.Radius
R.Thigh
L.Thigh
L.Thigh.Front
R.Thigh.Upper
L.Thigh.Rear
R.Thigh.Front
R.Shank
L.Shank
R.Shank.Upper
L.Shank.Front
R.Shank.Front
L.Shank.Rear
L.MedFoot
R.LatFoot
R.MedFoot

The markers shown in Figure F-6 on page F-24 are used by the Motion Module to control the degrees of freedom in the hand. If the three critical markers are present in the static trial, the Motion Module will load a detailed model of the hand with three joints in each finger. By default, all of the finger joints are fixed. SIMM converts them into hinge joints as it detects the presence of markers to control the joints. For example, if R.Finger2.M1, R.Finger2.M2, and R.Finger2.M3 are all present, SIMM will create three hinge joints in the index finger, each with its own degree of freedom. If only R.Finger2.M1 is present, SIMM will create the proximal finger joint with a degree of freedom, and make the two distal joints dependent on the proximal one (so that all three joints will flex when the proximal one does). Any combination of the optional markers can be used to create a hand model with the desired degrees of freedom. All of the optional hand markers are defined as "fixed" in the model file. This means that the offsets specified in the file are used for solving motions (the Motion Module does not overwrite them), and thus you should place the markers on the subject according to how they are shown in the figure below.

Figure F-6. Critical and Optional Markers for Hands


R.Finger3.M3
R.Finger4.M3
R.Finger3.M2
R.Finger2.M3
R.Finger4.M2
R.Finger5.M3
R.Finger2.M2
R.Finger3.M1
R.Finger4.M1
R.Finger5.M2
R.Finger2.M1
R.Finger5.M1
R.Thumb.M3
R.Thumb.M2
R.Hand
R.Thumb.M1
R.Radius
RWRA
R.Ulna
RWRB
R.Wrist
R.Wrist.Lateral
R.Wrist.Lat
RWRI
● critical markers for finger modeling
● Optional markers that add degrees of freedom to the finger joints

Starting with SIMM 4.0, support has been added for alternative critical marker sets for use with the Mocap Model. For example, the sacral marker can be replaced with two PSIS markers, and the lateral wrist marker can be replaced with the radius marker. It is thus difficult to display in a single picture of the body the complete set of markers that are required. On the following pages are descriptions of the critical and semi-critical marker sets for each portion of the body. Also, for each marker, the complete list of acceptable names is shown. Any one of these *case-insensitive* names in the list can be used to identify the marker in the **Cortex** capture.

Lower Body

The lower body portion of the Mocap Model will be loaded if the critical markers listed below are present in the static trial. The thigh, shank, and feet segments will each be scaled separately, based on measurements made from the static trial. Each of these segments will be scaled uniformly in the X, Y, and Z dimensions. The pelvis segment will be scaled independently in the X, Y, and Z dimensions. It is not possible to load only one leg of the Mocap Model.

Critical Markers

1. **Right ASIS.** acceptable names: R.ASIS RASIS RASI
2. **Left ASIS.** acceptable names: L.ASIS LASIS LASI
3. **Posterior pelvis:**

   a. Sacrum. acceptable names: V.SACRAL V.SACRUM SACRAL SACRUM SACR VSAC

   or

   b. Right PSIS. acceptable names: R.PSIS RPSIS RPSI

   and

   Left PSIS. acceptable names: L.PSIS LPSIS LPSI

4. **Right lateral knee**. acceptable names: R.KNEE R.KNEE.LATERAL R.KNEE.LAT RKNE
5. **Left lateral knee**. acceptable names: L.KNEE L.KNEE.LATERAL L.KNEE.LAT LKNE
6. **Right lateral ankle.** acceptable names: R.ANKLE R.ANKLE.LATERAL R.ANKLE.LAT RANK
7. **Left lateral ankle**. acceptable names: L.ANKLE L.ANKLE.LATERAL L.ANKLE.LAT LANK
8. **Right heel.** acceptable names: R.HEEL RHEE
9. **Left heel.** acceptable names: L.HEEL LHEE
10. **Right toe.** acceptable names: R.TOE RTOE
11. **Left toe**. acceptable names: L.TOE LTOE

Semi-critical Markers

1. **Right medial knee.** acceptable names: R.KNEE.MEDIAL R.KNEE.MED
2. **Left medial knee.** acceptable names: L.KNEE.MEDIAL L.KNEE.MED
3. **Right medial ankle.** acceptable names: R.ANKLE.MEDIAL R.ANKLE.MED
4. **Left medial ankle.** acceptable names: L.ANKLE.MEDIAL L.ANKLE.MED

Upper Body

The upper body portion of the Mocap Model will be loaded if the critical markers listed below are present in the static trial. The upper arm and lower arm segments will each be scaled separately, based on measurements made from the static trial. Each of these segments will be scaled uniformly in the X, Y, and Z dimensions. The torso segment will be scaled independently in two dimensions (the X is scaled the same as the Z). It is not possible to load the upper body with only one arm. To load only one arm (without the rest of the upper body), use the SIMM file rightArm.jnt or leftArm.jnt as the Mocap Model.

Critical Markers

1. **Right ASIS.** acceptable names: R.ASIS RASIS RASI
2. **Left ASIS.** acceptable names: L.ASIS LASIS LASI
3. **Posterior pelvis:**

   a. Sacrum. acceptable names: V.SACRAL V.SACRUM SACRAL SACRUM SACR VSAC

   or

   Right PSIS. acceptable names: R.PSIS RPSIS RPSI

   and

   Left PSIS. acceptable names: L.PSIS LPSIS LPSI
4. **Right shoulder**. acceptable names: R.SHOULDER RSHO
5. **Left shoulder**. acceptable names: L.SHOULDER LSHO
6. **Right lateral elbow**. acceptable names: R.ELBOW R.ELBOW.LATERAL R.ELBOW.LAT RELB
7. **Left lateral elbow.** acceptable names: L.ELBOW L.ELBOW.LATERAL L.ELBOW.LAT LELB
8. **Right wrist**:

   a. Lateral. acceptable names: R.WRIST R.WRIST.LATERAL R.WRIST.LAT RWRI

   or

   b. Radius. acceptable names: R.RADIUS RWRA
9. **Left wrist**:

   a. Lateral. acceptable names: L.WRIST L.WRIST.LATERAL L.WRIST.LAT LWRI

   or

   b. radius. acceptable names: L.RADIUS LWRA

Semi-critical Markers

1. **Right medial elbow.** acceptable names: R.ELBOW.MEDIAL R.ELBOW.MED
2. **Left medial elbow**. acceptable names: L.ELBOW.MEDIAL L.ELBOW.MED
3. **Right wrist**:

   a. Medial. acceptable names: R.WRIST.MEDIAL R.WRIST.MED or

b. ulna. acceptable names: R.ULNA RWRB

4. **Left wrist**:

   a. medial. acceptable names: L.WRIST.MEDIAL L.WRIST.MED

   or

   b. ulna. acceptable names: L.ULNA LWRB

Right Arm

To load only the right arm, set the MOCAP_MODEL parameter in your SIMM preferences file to *rightArm.jnt*, or choose that file using the *O***ptions…Choose Model Model** command in the SIMM menu bar. Then use the markers listed below.

Critical Markers

1. **Right shoulder.** acceptable names: R.SHOULDER RSHO
2. **Right lateral elbow.** acceptable names: R.ELBOW R.ELBOW.LATERAL R.ELBOW.LAT RELB
3. **Right wrist:**

   a. Lateral. acceptable names: R.WRIST R.WRIST.LATERAL R.WRIST.LAT RWRI

   or

   b. Radius. acceptable names: R.RADIUS RWRA

Semi-critical Markers

1. **Right medial elbow**. acceptable names: R.ELBOW.MEDIAL R.ELBOW.MED
2. **Right wrist**:

   a. Medial. acceptable names: R.WRIST.MEDIAL R.WRIST.MED

   or

   b. Ulna. acceptable names: R.ULNA RWRB

Left Arm

To load only the left arm, set the MOCAP_MODEL parameter in your SIMM preferences file to *leftArm.jnt*, or choose that file using the *Options…Choose Model Model* command in the SIMM menu bar. Then use the markers listed below.

Critical Markers

1. **Left shoulder**. acceptable names: L.SHOULDER LSHO
2. **Left lateral elbow.** acceptable names: L.ELBOW L.ELBOW.LATERAL L.ELBOW.LAT LELB
3. **Left wrist**:

   a. Lateral. acceptable names: L.WRIST L.WRIST.LATERAL L.WRIST.LAT LWRI

   or

   a. Radius. acceptable names: L.RADIUS LWRA

Semi-critical Markers

1. **Left medial elbow.** acceptable names: L.ELBOW.MEDIAL L.ELBOW.MED
2. **Left wrist**:

   a. Medial. acceptable names: L.WRIST.MEDIAL L.WRIST.MED

   or

   b. Ulna. acceptable names: L.ULNA LWRB

Right Hand

The right hand will always be included when the right arm is loaded, even if there are no markers on the hand. The presence of critical markers controls how the hand is scaled and what degrees of freedom it has. The right hand will be scaled separately from the right lower arm if the three critical markers listed below are present in the static trial. The individual finger gencoords will be added to the model if the three critical hand markers and the appropriate finger markers are present in the static trial.

Critical Markers

1. **Right thumb.** acceptable names: R.THUMB R.THUMB.M3
2. **Right middle finger.** acceptable names: R.MIDDLE.FINGER R.FINGER R.FINGER3.M3
3. **Right wrist:**

   a. Lateral. acceptable names: R.WRIST R.WRIST.LATERAL R.WRIST.LAT RWRI

   or

   b. Radius. acceptable names: R.RADIUS RWRA

Semi-critical Markers

1. **Right wrist**:

   a. medial. acceptable names: R.WRIST.MEDIAL R.WRIST.MED

   or

   b. Ulna. acceptable names: R.ULNA RWRB

Left Hand

The left hand will always be included when the left arm is loaded, even if there are no markers on the hand. The presence of critical markers controls how the hand is scaled and what degrees of freedom it has. The left hand will be scaled separately from the left lower arm if the three critical markers listed below are present in the static trial. The individual finger gencoords will be added to the model if the three critical hand markers and the appropriate finger markers are present in the static trial.

Critical Markers

1. **Left thumb**. acceptable names: L.THUMB L.THUMB.M3
2. **Left middle finger**. acceptable names: L.MIDDLE.FINGER L.FINGER L.FINGER3.M3
3. **Left wrist**:

   a. Lateral. acceptable names: L.WRIST L.WRIST.LATERAL L.WRIST.LAT LWRI

   or

b. Radius. acceptable names: L.RADIUS LWRA

Semi-critical Markers

1. **Left wrist**:

   a. Medial. acceptable names: L.WRIST.MEDIAL L.WRIST.MED

   or

   b. Ulna. acceptable names: L.ULNA LWRBb

Head

The head will always be included when the upper body is loaded, and the neck will contain three degrees of freedom. If the critical markers listed below are present in the static trial, the head will be scaled separately from the torso. Otherwise, the head will be scaled uniformly by the scale factor used for the Y (height) of the torso. If no markers (critical or optional) are included on the head in the static trial, then the degrees of freedom in the neck will remain fixed during imported motions.

Critical Markers

1. **Rear of head.** acceptable names: HEAD.REAR REAR.HEAD HEADREAR REARHEAD
2. **Top of head.** acceptable names: HEAD.TOP TOP.HEAD HEADTOP TOPHEAD
3. **Front of head.** acceptable names: HEAD.FRONT FRONT.HEAD HEADFRONT FRONTHEAD

The following optional markers are already defined in **mocap.jnt**. To use them, just put their exact names in your **Cortex** capture:

pelvis: R.Trochanter
L.Trochanter

thorax: Offset
Sternum
T10
CLAV
STRN
RBAK

cerv7: C7
C7 Spinous Process

head: R.Ear
L.Ear
RBHD
RFHD
LBHD
LFHD
HEDO
HEDP
HEDA
HEDL

clavicle_l: L.Clavicle

scapula_l: L.Scapula
L.Scapula.Top
L.Scapula.Bottom
L.Angulus Acromialis
L.Trigonum Spinae
L.Angulus Inferior

humerus_l: L.Bicep
L.Biceps.Lateral

ulna_l: L.Forearm

femur_l: L.Thigh
L.Thigh.Upper
L.Thigh.Front
L.Thigh.Rear
LTHI

tibia_l: L.Shank
L.Shank.Upper
L.Shank.Front
L.Shank.Rear
LTIB

foot_l: L.MedFoot
L.LatFoot

clavicle_r: R.Clavicle

scapula_r: R.Scapula
R.Scapula.Top
R.Scapula.Bottom
R.Angulus Acromialis
R.Trigonum Spinae
R.Angulus Inferior

humerus_r: R.Bicep
R.Biceps.Lateral

ulna_r: L.Forearm

femur_r: R.Thigh
R.Thigh.Upper
R.Thigh.Front
R.Thigh.Rear
RTHI

tibia_r: R.Shank
R.Shank.Upper
R.Shank.Front
R.Shank.Rear
RTIB

foot_r: R.MedFoot
R.LatFoot

Appendix G

Synchronizing Digital Video with Cortex

Topic	Page
CortexDV Overview	G-1
System Requirements	G-1
Installation	G-2
Using CortexDV	G-2
Currently Open Known Issues	G-4

CortexDV Overview

CortexDV is a Digital Video (DV) capture application for use with Motion Analysis Corporation's **Cortex** software for the synchronized capture of reference video data on a separate Windows PC as ***.avi** files. You can directly transfer digital information back and forth between a DV camcorder and your computer with the use of the IEEE 1394 standard, also known as a Firewire or i.Link connection. If your computer does not come with this interface built into it, you will need to purchase an inexpensive card that provides the correct port.

You can run **CortexDV** on your local machine that has **Cortex** running on it (not recommended) as well as with remote machines that are connected to digital video cameras.

Note: Any standard DV camcorder should be sufficient for use with the **CortexDV** software. All **CortexDV** testing and product development was done with a Sony™ DCR-TRV520 NTSC model DV camcorder.

System Requirements

Recommended Minimum Specifications

- **Microsoft Windows XP, Vista, or Windows 7**
- 256 MB RAM
- 80GB (or more) free hard drive space (for captured files)
- CD-RW drive
- Ethernet card

Installation

We recommend you install the software into the **C:\Program Files\Motion Analysis\CortexDV** directory, but **CortexDV.exe** will run from any folder.

Note: No dongle or license file is required to run this application. But to collect synchronized reference video (AVI files) in **Cortex**, you need the [Reference Video 3.0] line in your mac_lic.dat license file.

Using CortexDV

Overview

To use **CortexDV**, you will need the Reference Video license entry in your Motion Analysis license (mac_lic.dat) file. For more information on this license, please contact Motion Analysis Customer Support (support@motionanalysis.com).

Note: You must also activate (check) the **Reference Video (.avi)** check box (in the **Motion Capture > Output** panel) for **CortexDV** to work.

Cortex sends an Ethernet packet to **CortexDV** to start and stop the capture. It also tells the name and number of the current capture. Systems that have more than one Ethernet port must specify which Ethernet port to use. Using the same Ethernet port that the cameras use works fine for most systems. You can designate which Ethernet port to use with the **AVI Remote Signal Output** function in the **Tools > Settings > Misc** tab. This has a pull-down list of the Ethernet ports known to Cortex when it was launched.

Capturing Digital Video Using CortexDV

1. Launch **CortexDV.**
2. Select the desired camera/capture device from Camera dropdown. If there is a single video camera connected to the host system, **CortexDV** connects to this camera automatically.
3. Select a Capture Folder to indicate where captured files should be stored.
4. Select a Capture File to indicate the name of the file that will be created.
5. To begin recording, press the **Record** button (red circle). A red RECORD will display next to the player control panel indicating the system is recording, and a message will be displayed in the Message Bar indicating record start time.
6. To stop recording, press the **Stop** button. The red RECORD will disappear and a message will be displayed in the Message Bar indicating recorder filename, stop time, and any available statistics.

Capturing Digital Video in CortexDV from Cortex

Note: **[Cortex]** indicates the action needed on the Cortex computer. **[CortexDV]** indicates the action needed on the CortexDV computer.

1. Ensure the **CortexDV** host and the **Cortex** host are connected to each other via a TCP/IP network connection.
2. **[CortexDV]** Launch **CortexDV** on the video capture host.
3. **[Cortex]** Launch **Cortex** on the **Cortex** host.
   Note—launch order is unimportant, however if **Cortex** grabs the camera/capture device first (i.e. displays Reference Video window) **CortexDV** will not have access to the camera. **Cortex** will grab the camera when you press the **F1** key in a capture window and release it when you select another key (**F2, F3**, etc.).
4. **[CortexDV]** Select the desired camera/capture device from Camera dropdown. If there is a single video camera connected to the host system, **CortexDV** connects to this camera automatically.
5. **[Cortex]** Activate the Reference Video (*.avi) checkbox in the **Motion Capture > Output** panel. Press the **F1** key to show video and grab the DV camera.
6. **[Cortex]** Press the **Record** button.
7. **[CortexDV]** On Record, **CortexDV** will record the file specified by **Cortex** to the directory specified by **Cortex** or, if not present, to the local Capture Folder. The Message Bar indicates the directory requested by **Cortex**.
8. **[CortexDV]** On Record, A red "RECORD" will display next to the player control panel indicating system is recording, and a message will be displayed in the Message Bar indicating record start time.
9. **[Cortex]** Stop recording by pressing either the **Stop** button or after reaching the duration specified.

Note: If you have more than one computer running **Cortex** on the same network, the **CortexDV** software does not consume the plugin port (as does the streaming Alias/MotionBuilder online plugin, for example). The message about starting and ending the data capture is broadcast to the x.x.x.255 address which means that all computers connected can hear the message and start and stop the recording. So you should be able to connect as many **CortexDV** recorder-computers up as you need.

Note: You probably will not want the AVI files streaming across the network.

Note: When VC files are collected, AVI files are collected. If VC files are not collected, AVI files are not collected.

Suggestion for DV Camera Setup

Sony™ DV cameras have a setup mode called **FRAME/FIELD**. The **FRAME** setup mode works best as it eliminates the “motion blur” which results from the **FIELD** (also known as Interleaved) mode. On Canon™ DV cameras, you will want to select **MOVIE** mode.

Procedure for Moving Reference Video Files from Another Location

1. Record a capture with an avi located in an alternate location (e.g. e:\data\captures).
2. Move or copy the avi to the directory containing the capture (or wherever you want it).
3. Click on the Capture Inspector tab in the **Plugins > Assistant** panel.
4. Select the avi in the capture location at the original location and select **Remove File From Capture**.
5. Select **Add Reference Video File to Capture**, and browse to find the moved avi.

Currently Open Known Issues

- Interface is evolving.
- Resizing video window by dragging corner can cause a hang-up. Stop, resize, play is a resolution for this.
- File recompression functionality unstable with certain compressors.
- Multiple camera support is working, however certain cameras (Sony) dislike it, and will give a "fail on run" message.
- Snapshot **.tga** image is incorrect.

Known Graphic Card Issues

There is a known problem displaying the AVI files when a 3D window is displayed on a Windows XP system. The AVI file plays in a jerky motion and the screen is sometimes sliced into horizontal blocks.

This is a problem with Open GL and Direct X displaying at the same time. Right-click on your desktop, then select **Properties > Settings > Advanced > Troubleshoot**. Slide the Hardware Acceleration down a few points. Quit **Cortex**, then re-launch. See if that fixes the problem. The settings depend on what your graphics card does and has for features that changes from one computer to another. If that does not fix the problem, try to slide the Hardware Acceleration to **None**. Quit **Cortex** and then re-launch. If that still does not fix the problem, try to change some of the Open GL settings found under the name of your graphics card (found under the **Properties > Setting > Advanced** tab). Also, change the Vertical Sync setting to **On by Default** and restart your computer.

Appendix H

Questions and Answers for Specific Applications

Question

Does **Cortex** *require a specific order for markers and linkages?*

Answer

For the identification of markers to work swiftly in real-time the order of marker definitions is important. You should follow these rules.

1. Markers should be ordered such that each successive marker builds the character top to bottom through linkages (i.e. Head to Neck, down one arm, then down the other, down the torso to the hips, down one leg, then the other). Do not backtrack.
2. If the first markers are linked into a stiff triangle, marker identification will be swift. For this reason, the head markers should always be first. Linkage order may affect the rectify process. For the head, a linkage order of 1-2, 1-3, and 2-3 works well.

Question

How can I prevent ghost markers from appearing?

Answer

1. Ghost markers may appear if the Max. Residual value is set too low. This parameter is set in the tracking function in the Motion Capture mode (except for centroid function instead of tracking).
2. Set the minimum number of cameras to 3.
3. Increase the minimum number of lines per marker

Question

How do I control the length of a recorded file in **Cortex***?*

Answer

All the recording options are set in the Output function in the Motion Capture mode.

When the record button is clicked using the trigger or the mouse, a new file is recorded and saved with the name, directory, and output type(s) you have specified. The recording will stop when either:

- the duration in seconds is reached
- the **Stop** button is clicked using the trigger or mouse

The default duration is 60 seconds. If you always want to control the end of the take with the trigger or mouse, we recommend setting the duration to a number that is higher than the trials you usually capture such as 10 minutes (600 seconds).

Question

Can ***Cortex*** *be used in a large capture volume (for example 50’x50’, 50 cameras)?*

Answer

If care is taken during setup, motion capture will work well in a large volume. The four areas requiring attention are:

1. **Camera Setup**—Are your cameras covering your volume efficiently? Are you using an overlapping volume setup? If not, you may have too many cameras seeing the same area. Over coverage can result in an over abundance of data, slowing the system down.

Note: Try to have no more than three cameras see any given area of the capture volume from one direction and 10 to 12 cameras total.

2. **Calibration**—Tracking residuals should be below 2.0 mm. If not, try raising the Max. Residual value. Too low a value may cause ghost markers to appear.
3. **Template**—Verify that marker identity is being performed quickly. Click the **Reset IDs** button several times while the actor is in the capture space and see if there is a lag in acquiring marker identification. If there is a lag, you may need to create a better template. Verify that the first three markers are the head markers and that the first three links form a rigid triangle. Finally, verify that remaining link definitions flow down the body following the marker definitions.
4. **Frame to Frame Rectifying**—This is mainly influenced by your 3D data quality and tracking parameters. Too many extra, stretchy linkages can cause problems here.

Question

Can I use MoCap Solver, Si 2.0, or Calcium in ***Cortex****?*

Answer

Yes. Export a MOD file from Si/Calcium and name it the same as the capture file. Select **Model Edit > Tree View** and then select **Calcium Solver** in the Skeleton Engine field.

Question

What is the order of the data in the TRC or TRB files when you use MTOs for tracking?

Answer

The resulting **.trc** file from MTO tracking should match the marker order of the resulting "Merge MarkerSets" operation.

Question

If I have a Solver skeleton setup from ***EVa 6.x****, can I use it in* ***Cortex****?*

Answer

Yes, if you go to the **Model Edit > Tree View** panel and in the Skeleton Engine field, you check **Calcium Solver.** in **Cortex.** You must also copy the MOD file into your current capture folder with the same name as your current PRJ file.

Question	*If I have the* **EVa 6.X** *Solver setup, can I get an HTR file from* **Cortex***?*
Answer	Yes. Select the Calcium Solver Skeleton Engine button (Bone button, in lower left of the Post Process dashboard), then select **File > Export HTR File....**
Question	*What are the tradeoffs in capturing at 120 fps or faster or slower with Motion Analysis cameras?*
Answer	With the older analog cameras, there were tradeoffs in image quality as the frame rate went up. With the newer digital cameras, we see no degradation AT ALL with the higher frame rates, which is great for high speed captures. The images are all taken off of the sensors in 2 msec which corresponds to the 500 fps. Waiting longer between frames does not degrade or enhance the image quality. The only considerations are Ethernet bandwidth (not generally a problem), disk space used, and time to process (or post-process) the raw VC files.
Question	*Are there any rules that should be followed when deciding which camera should be set as "Master"?*
Answer	Any camera can be master. If you have an A-D system, the master camera must be connected to it using the A-D sync cable.
Question	*When you see a marker in the 2D display, are you simply seeing a digital representation of what the camera sees at the CCD, or are any of the tracking parameters incorporated into determining whether the system "sees" a marker (i.e. marker size, centroid parameters, etc.)?*
Answer	The black data is the raw edge data, affected only by the lighting and the Threshold. The red dots (lens corrected and/or not) are the calculated centroids. To calculate a centroid, there are two main things: 1) Min Lines per Marker (usually set to 2 or 3 lines), 2) Max. lines per Marker (usually set to a BIG number like 100), and Shape Analysis (None, Normal or Weak), normally to Normal. But sometimes it is set it to None if it is tossing out centroids, like during a L-Frame seed calibration.
Question	*Can you connect 7 or 8 cameras to an EagleHub? We tried connecting 8 cameras to an EagleHub2 and the data transfer to the gigabit switch became quite unstable. Note that this pertains to the older 8-port EagleHubs only (not the 12-port EagleHubs).*
Answer	There are only 8 useful ports on an older model EagleHub, which means 7 cameras can be connected to the EagleHub, and one more is used for the uplink to the Network Interface Card (NIC). An eighth camera can be connected directly to one of the remaining open port son the NIC using a patch cable.

Question

Is there a way to have two templates for two people in the capture that identify them both in real time at once, rather than using one huge template that includes everything?

Answer

This is the MTO (Multiple Tracking Object) item. Refer to “Multiple Tracking Objects” on page 9-7.

Question

What does the extend template option do?

Answer

Extend Template adds new linkage stretch to the existing template if you need it. For example, you can make a one frame template, ID some motion, then you can extend the template so that it knows about the new motion linkage stretches as well as the old ones.

Question

What are the latest specifications for the Motion Analysis system performance?

Answer

From the 5 person Eagle camera data included in the **Cortex** release package under the Samples folder:

- Trial: FivestarsAgainandAgain.VCX: 1800 Frames, 120 Frames/sec. per the Cortex software.
- Biggest VC file: 3900 KB (highest data rate), Smallest VC File: 1100 KB, Avg. VC. size about 2500 KBytes.
- Data rate per Eagle camera: Max size file: 3900 KBytes X 120 Frames/sec X 1/1800 Frames = 260 KBytes/sec or about 2600 Kbps (kilobits/sec) or 2.6 Mbps or about 2.6% of the 100 Mbps Ethernet or about 0.26% of the 1000 Mbps Ethernet
- Avg. size file: 2500 KBytes X 120 Frames/sec X 1/1800 Frames = 166 KBytes/sec or about 1660 Kbps or about 1.6% of the 100 Mbps Ethernet

So, what does this mean for your 12 Camera Setup?

For a 5 person Eagle camera capture, with an average data rate for 120 Hz capture per camera, it works fine (about 1660 Kbps X 12 cameras = 19,920 Kbps or about 20% of the available Ethernet bandwidth). We used a Gigabit Ethernet NIC and Switch for our 24 camera setup. That used about 4% of the 1000 Mbps Ethernet, but would have been 40% of the 100 Mbps Ethernet, which could result in lost packets. The **Cortex** software is robust enough to deal gracefully with lost packets by ignoring the empty frames and continuing with the capture.

This also provides another dataset in the Samples folder, **Dave Face and Body**: one person, 60 Frames/sec, 400 Frames, 300-600 KBytes per camera, average maybe 450 KBytes (450 KBytes X 60 Frames/sec X 1/400 Frames = 68 KBytes /sec or about 680 Kbits/sec or about 0.7% of the 100 Mbps Ethernet).

For your 12 camera setup, this would be: 680 Kbps X 12 cameras = 8160 Kbps or about 8% of the 100 Mbps Ethernet.

Question

Why is there is a problem displaying the AVI files when a 3D window is displayed on a Windows XP system? The AVI file plays in a jerky motion and the screen is sometimes sliced into horizontal blocks.

Answer

This is a problem with Open GL and Direct X displaying at the same time. Right-click on your desktop, then select **Properties > Settings > Advanced > Troubleshoot**. Slide the Hardware Acceleration down a few points. Quit **Cortex**, then re-launch. See if that fixes the problem. The settings depend on what your graphics card does and has for features that changes from one computer to another. If that does not fix the problem, try to slide the Hardware Acceleration to **None**. Quit **Cortex** and then re-launch. If that still does not fix the problem, try to change some of the Open GL settings found under the name of your graphics card (found under the **Properties > Setting > Advanced** tab). Also, change the Vertical Sync setting to **On by Default** and restart your computer.

Question

We came across a problem while in a two person w/ prop motion capture session. Whenever we recorded a motion, the recorded trc file would be missing a good portion of the marker data. Any idea why the data would just disappear?

Answer

This is most likely cause by insufficient marker slots. The default marker slot setting is 192. In your case, you should increase the value. The marker slot setting maybe adjusted under **Tools > Settings > Misc**.

Question

We are only using 93 markers (40 per actor, 5 per prop, and 3 for the ball). Shouldn't 192 marker slots be enough?

Answer

Not necessarily. You should always have at least twice as many marker slots then actual markers. The number of slot is dependent on the tracking parameters settings. Each snippet of trajectory requires its own slot and different parameter values will create different sets of trajectories.

Question

How will I know if I need more marker slots?

Answer

After loading the file (trb/trc). In Post Processing Mode, scroll down the unnamed marker list (u_marker). If the all the slots are filled then you should increase the number of marker slots.

Question

I just made some changes to my capture file, but I do not want to recapture the entire motion list over again. Is there any way to rebuild the trb/trc data from the VC files?

Answer

Yes. You can re-record the tracks files using the updated set of parameters in **Cortex**. First load the VC files. Then go to the **Motion Capture > Output** panel. Select to export a trb or trc file, you have to select the option **OK to Overwrite** if the tracks file already exists. Click on **Record**. The recording will automatically stop at the end of the VC file as long as the option "Loop Raw Files" is not checked (in the **Tools > Settings > Play-**

back tab). If it is checked then you will have to stop it by pressing the **Stop** button (same as the Record button, it changes name during the recording).

Question

Our templates in Cortex are always either extremely good or extremely poor. Can you give us some time so we can get a consistently good template each time?

Answer

The first step of the process is to collect both an init pose and a ROM(range of motion) for the actor. Do a manual identification of the makers in the init pose (T-pose or A-pose). Use this to create your template.

You should next be able to ID the first frame of the ROM (which should be a T-Pose) and do a Rectify through the whole ROM. Once the ROM has been completely identified, save the changes and then use Extend Template from the Create Template Dialog box.

The next step is to process all the easier motions. This way you can use these motions to extend your template further which will allow you to have a more complete template by the time you need to track the harder motion files.

Question

I'm in the process of setting up **Cortex** *to collect video data, and I have a question about compatible video devices. The manual indicates that a Sony camcorder with Firewire output was used in testing. Would it be acceptable to run, for example, a surveillance camera through a capture device with a Firewire output?*

Answer

Currently, Cortex looks for DV format streams over Firewire/IEEE1394 only, using those devices designed to operate with the Microsoft DV driver (MSDV).

A device delivering data over Firewire will likely use the MSDV driver if the data is in the 'DV' format, which refers to a specific compression codec (DV25), which is what most consumer handycams deliver.

WebCams, as a counter example, tend to deliver compressed Mpeg-2 streams. So it would not matter if the WebCam used USB or Firewire. If it delivers Mpeg-2 streams over Firewire, then it currently would not be recognized by EVaRT.

When evaluating a suitable camera, Firewire with DV25 is recommended.

More types of cameras are scheduled for inclusion into the "Reference Video" option in the future. Please check with support@motionanalysis.com for an updated list.

Question

When I load a capture with an avi file in Cortex, I get a popup error that reads "Can not add the atudio renderer.” It loads the marker data but not the avi file.

Answer

The problem was caused by faulty or buggy device drivers for the sound card. Updating the drivers for the sound card may fix the problem.

Appendix I Useful Blank Forms

Topic	Page
Motion Capture Log	I-2
Human Body Outline—Front	I-3
Human Body Outline—Side	I-4
Human Body Outline—Back	I-5

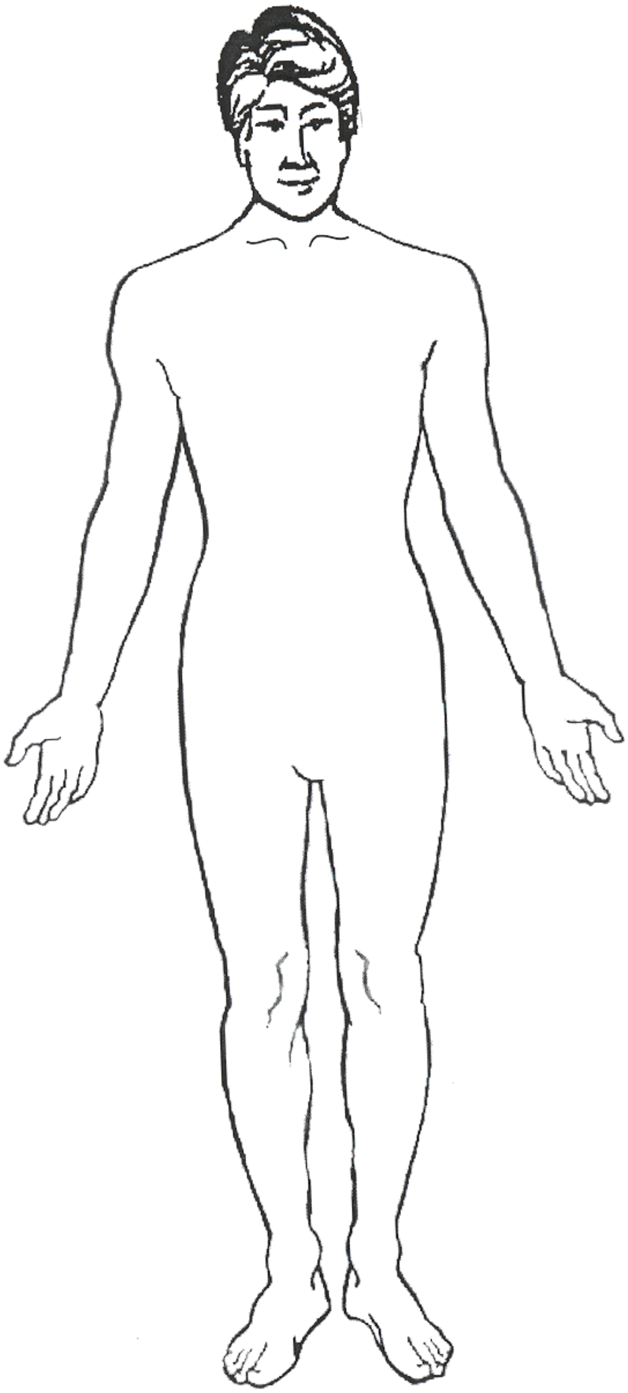
The following blank forms may be useful to prepare for and document a motion capture session. Feel free to make copies as needed.

Motion Capture Log

Date ______/_____/________			**Client ____**		
Take #	**Cortex Filename**	**# Seconds**	**Ref. Video Counter**	**Comments**	**Results**

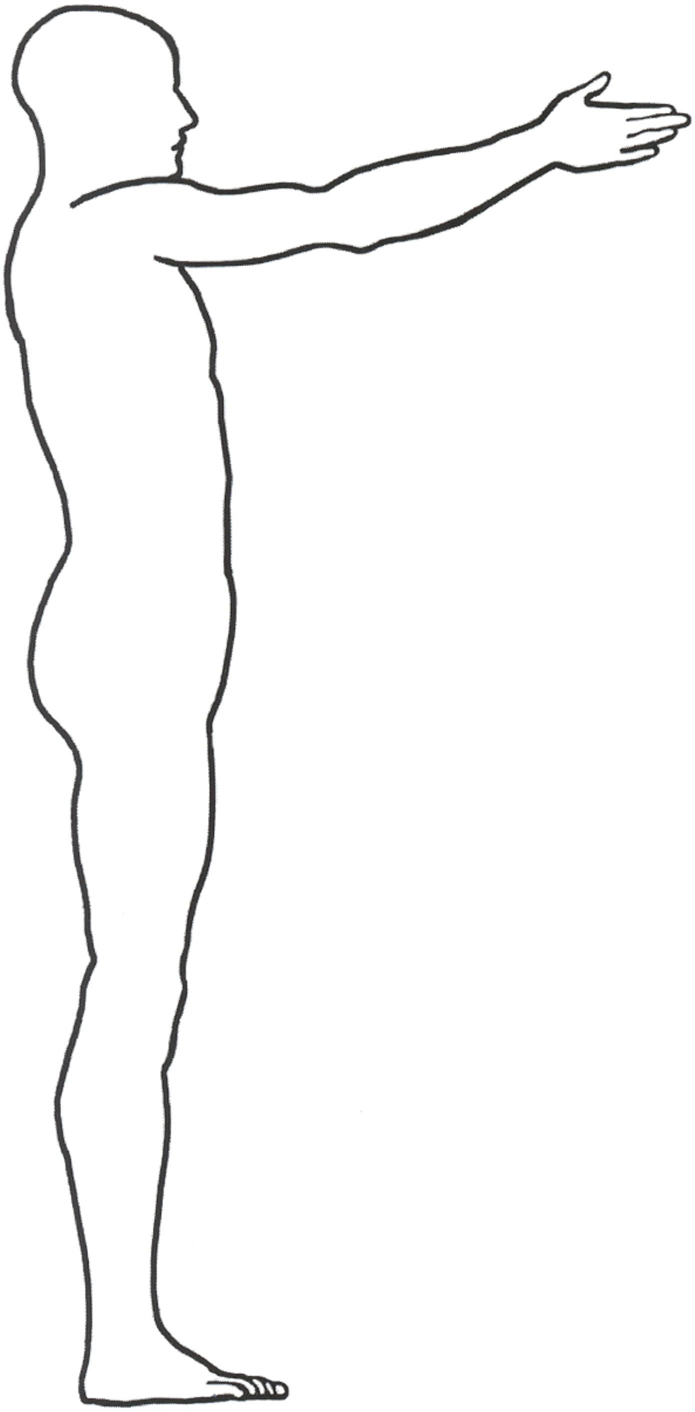
Human Body Outline—Front

Project____Date______/_____/____



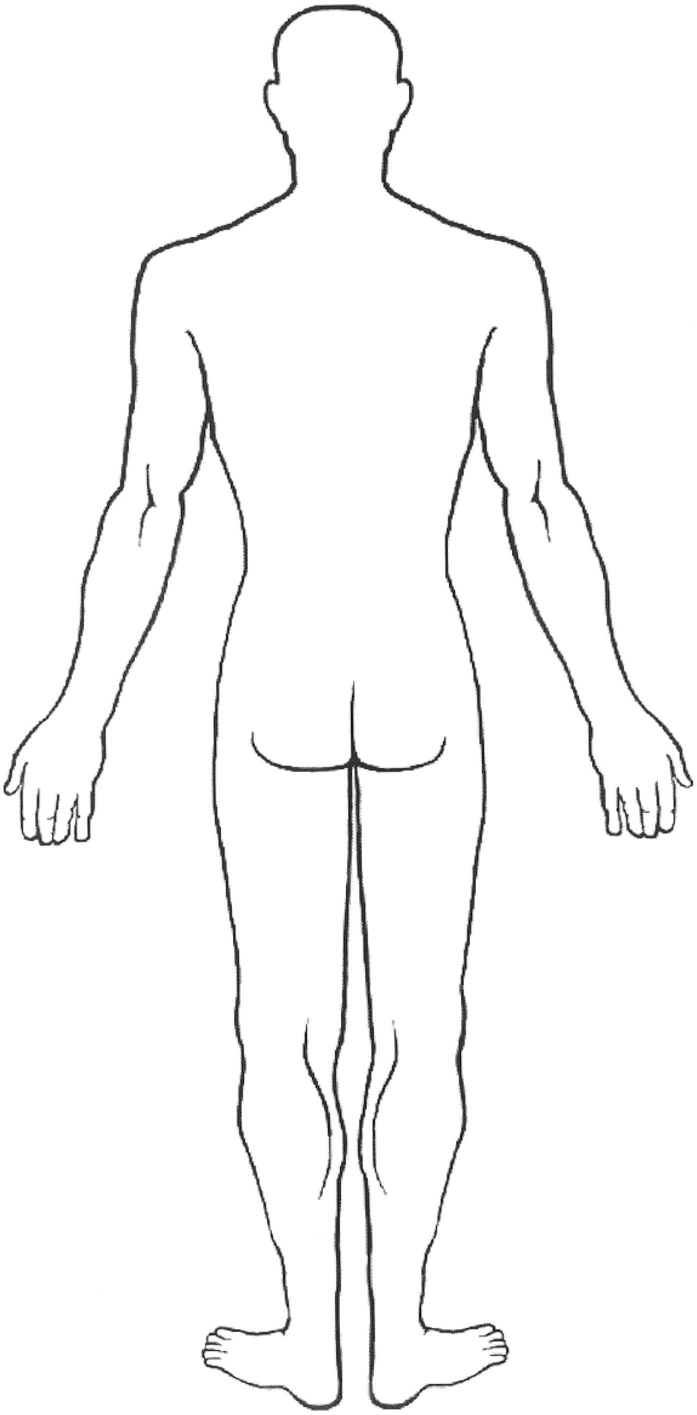
Human Body Outline—Side

Project____**Date**______/_____/____

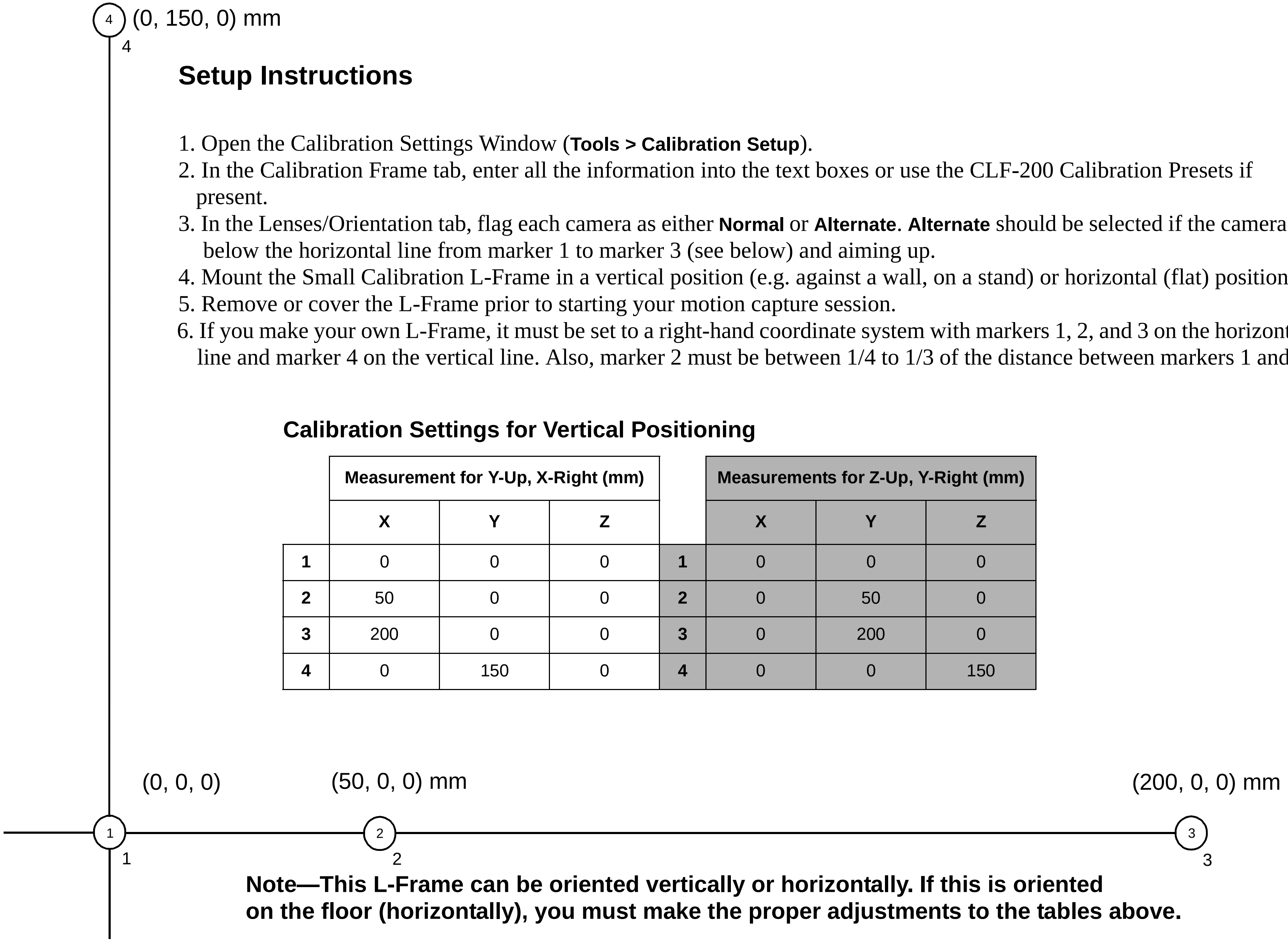


Human Body Outline—Back

Project____**Date**______/_____/____



CLF-200 Small Calibration L-Frame (200 mm)



Setup Instructions

1. Open the Calibration Settings Window (**Tools > Calibration Setup**).
2. In the Calibration Frame tab, enter all the information into the text boxes or use the CLF-200 Calibration Presets if present.
3. In the Lenses/Orientation tab, flag each camera as either **Normal** or **Alternate**. **Alternate** should be selected if the camera is below the horizontal line from marker 1 to marker 3 (see below) and aiming up.
4. Mount the Small Calibration L-Frame in a vertical position (e.g. against a wall, on a stand) or horizontal (flat) position.
5. Remove or cover the L-Frame prior to starting your motion capture session.
6. If you make your own L-Frame, it must be set to a right-hand coordinate system with markers 1, 2, and 3 on the horizontal line and marker 4 on the vertical line. Also, marker 2 must be between 1/4 to 1/3 of the distance between markers 1 and 3.

Calibration Settings for Vertical Positioning

	Measurement for Y-Up, X-Right (mm)		
	X	**Y**	**Z**
1	0	0	0
2	50	0	0
3	200	0	0
4	0	150	0

	Measurements for Z-Up, Y-Right (mm)		
	X	**Y**	**Z**
1	0	0	0
2	0	50	0
3	0	200	0
4	0	0	150

Note—This L-Frame can be oriented vertically or horizontally. If this is oriented on the floor (horizontally), you must make the proper adjustments to the tables above.

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